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ELEMENTS

OF

BLEACHING.

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BRITISH MUSEUM
10 APR 63

ELEMENTS

OF

BLEACHING.

Θήγει φρένα τὸ ἡδὺ τεχνῶν.

By JOHN CURRY,
STUDENT IN THE COLLEGE OF EDINBURGH.

DUBLIN: PRINTED BY W. G. JONES,
MDCCLXXIX.

BRITISH MUSEUM
10 APR 63

TO THE

RIGHT HONOURABLE

JAMES FORTESCUE, Esq.

SIR,

YOUR great knowledge of the arts and ſciences, firſt led me to beg the favour of you to look over theſe papers before I would venture to publiſh them.

I NOW preſume to dedicate them to you; for, to whom could I with ſo much propriety inſcribe a work of this kind, as to one who has always ſtudied to encourage our linen manufacture, and who has alſo ever been active and attentive to promote the happineſs and welfare of this iſland.

I am, Sir,

Your very obedient,

Humble ſervant,

JOHN CURRY.

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INTRODUCTION.

PHILOSOPHERS have always entertained a very high opinion of ſcience, and are perſuaded, that our mental endowments, and acquiſitions, conſtitute the great diſtinction between our nature and that of the brute creation; but fact, ſtronger than any deduction of argument, is againſt them, and the experience of all ages ſhews that they are miſtaken.

AN unprejudiced ſurvey of mankind is ſufficient to prove, that both the manners and knowledge of men have been more poliſhed and improved by an attention to the meaner part of our conſtitution, than by all the ſcientifical labour of the philoſopher.

THIS is not all. This ſcience, of which we think ſo favourably, muſt own for its part, thoſe lower employments which the philoſopher is but too ready to regard with contempt.

WE owe philoſophy, in all its branches, to the arts, and perhaps not one ſingle art to philoſophy.

IF we take an unprejudiced view of the difference between our ſpecies, and the reſt of the animal creation, we will find, that the remarkable diſtinction ariſes from the great multiplicity of our wants, and the difficulty of ſupplying them. Man is not ſo eminently diſtinguiſhed by the variety of his talents, or the extent of his capacity; even this reaſon, and this invention of which we boaſt, as the prerogative of our ſpecies, are the reſult of our neceſſities. We ſee in all the ſpecies of animals a gradation in talents, correſponding to a gradation in wants, and the difficulty of their ſupply.

Now, of all the animals in the creation, man is the moſt needy, his attention is directed to a great variety of objects at once; hunger ſends him abroad in queſt of food, his delicate body is unable to bear the inclemency of the ſeaſons, and he muſt make to himſelf ſome ſhelter, for nature affords none ſufficient for his feeble conſtitution; his natural weakneſs, his diſtaſte for ſolitude, drives him into ſociety; there he finds others as needy and as weak as himſelf, competitions of wants are inevitable and fatal, he muſt arm himſelf againſt his fellow-men.

NOT exhauſted by this variety of purſuit, man has an unſatiable deſire of change, unknown to other animals. The food which this week pleaſes his palate, diſguſts him the next, and he muſt ſeek for another. Nature, with all her ſtores, is not ſufficient for his love of novelty.

MAN is alſo a nice creature, and there is no gift of nature ſo exquiſite, but his freakiſh fancy muſt mould it to his taſte, by putting it out of its original form; this is the caſe, even in ſupplying his moſt preſſing wants, and ſeems even neceſſary for his well-being. The delicate juice of the grape diſagrees with his ſtomach, and muſt be made into wine.

THE warm fur of the ſheep is inconvenient, and muſt be woven into cloth.

The ſhade and timber of the wood muſt be faſhioned into a hut: in ſhort, his whole employment ſeems to be putting things out of their natural ſtate.

But, as if all this diverſity of attention, all this difficulty conſequent on it, did not ſufficiently employ him, there is ſuperadded to his conſtitution, an inſatiable principle of luxury and refinement; his very natural wants he refines into inſtruments of pleaſure; not content with wholeſome food, he muſt have it ſeaſoned; he changes his blanket for a laced coat, and his hut for a palace; he converts ſexual luſt into an elegant paſſion: he has flower-gardens as well as corn fields. Not contented with beholding beautiful objects abroad, he paints them at home; not being able to be a performer, or ſpectator of noble actions, he hires poets and hiſtorians to relate them.

THE moſt pleaſant ſounds are without entertainment, unleſs ſubjected to the rules of muſic. Nay, the very means of ſupplying his natural wants, he refines into ſports and hunts, though not hungry.

SUCH, and ſo various are the wants of men, all concur in turning our attention without ceaſing to the objects around us.

As our taſk of acquiring the knowledge of external things is ſo various, and as our power muſt ever be in proportion to our knowledge; nature, who is always kind to her children, has implanted in our minds a love of diſcovery, and diſintereſted curioſity: other animals reſemble us in many reſpects; like us, they acquire by experience, the habitual knowledge of many relations of things; they reaſon and act in conſequence of this knowledge preciſely as we do, but of diſintereſted curioſity they exhibit no trace. We ſometimes behold them ſeemingly prying into matters, but more careful obſervation ſhews that it is always to anſwer ſome immediate purpoſe. An indiſputable proof of the fact is, that we ſee them accumulate no ſtock of knowledge to the ſpecies, which exhibits the ſame appearance to day, as a thouſand years ago: but, in man, diſcovery and invention are for their own ſakes objects of purſuit. Curioſity becomes a principle of action in all men, as far as is neceſſary for the general purpoſes of life: at the ſame time the Author of nature has rendered it ſo prompt in ſome men, as to abſtract them from every other purſuit.

THE firſt acquiſition of the human mind will be that of arts; the knowledge of means conducive to certain ends;

but, as men improve their ſituation, and become more at eaſe, eſpecially after the introduction of agriculture, *&c.* they will find more time to ſtudy the nature and property of things; or the ſtudy of nature will become the object of purſuit to ſome.

In ſhort, arts are founded on knowledge, and are refined into ſciences, and the art, or ſcience of logic ariſes, and at laſt is refined into metephyſics, or abſtract philoſophy.

Science therefore is the child of luxury, the refinement on neceſſary contrivance, it is therefore in its own nature pleaſant.

The man of pleaſure, and the philoſopher, regard the hunger, and labour of the man of buſineſs with equal diſdain, and this they do with equal injuſtice, for they forget that they themſelves are the only ſuperfluities of ſociety: but the luxury of the philoſopher has this eminent advantage above that of the man of pleaſure, his may be directed in ſuch a manner, as may make it ſubſervient to the general good.

THE mind of no man is able to graſp at all its objects; ſcience therefore has acquired its preſent improvement, in conſequence of different philoſophers having been led to different paths of enquiry; it will continue ſtill farther to improve, by the improvement of arts, which will be daily furniſhing it with new objects, and new diſcoveries.

THE arts will daily improve by a more compleat diviſion of labour, and by the artiſts calling on a ſet of men to think for them, leaving no more in their own hands than the execution of the orders of the ſpeculiſt: as in *China*, the art of government is performed by a profeſſed diviſion of the taſk between the Thinkers, and Signers*.

THUS, both art and ſcience will moſt ſucceſsfully improve, by acting in concert, and thoſe ſciences will always improve moſt, which are moſt immediately connected with the arts.

I DO not know any branch of ſcience († Natural Philoſophy excepted) that more immediately ſprings from the arts of life, than Chemiſtry, none that is more indebted to them for information, and none which has made more liberal returns.

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* Raynal.

† By Natural Philoſophy, I mean that ſcience which conſiders the ſenſible motions and actions of bodies.

Chemiſtry conſiders the inſenſible motions and mutual actions of the inſenſible particles of matter.

But let us attend more particularly to the ſubject of our ſpeculation:

And, although I have ſaid that we acquire a knowledge of the arts, &c. analitically, yet the ſynthetic is the moſt convenient method of teaching them: and, in order for a man to be a good ſpeculative bleacher, it is neceſſary that he ſhould be well acquainted with chemical philoſophy; but men who have theſe advantages, ſeldom pay any attention to the meaner arts; whilſt, on the other hand, few, very few practical bleachers know the properties which diſtinguiſh an alkali from the acid, altho theſe are the bodies which they employ to anſwer their intention of whitening linen.

ELEMENTS

OF

BLEACHING.

AS nothing can conduce more to the improvement of bleaching, or the art of whitening linen, than a knowledge of the bodies employed in that art, I ſhall, therefore, in the firſt part of this elementary treatiſe, endeavour to explain the properties of theſe bodies, with reſpect to heat and mixture, that thereby the bleacher may be enabled to judge nicely of their comparative values; and, in the laſt part, I ſhall conſider the application of theſe bodies; that is, I will treat of the operations in bleaching; in doing which, I ſhall attempt a theory or explanation of phenomena, with a view to engage the attention of the ſpeculative bleacher, that thereby greater improvements may be made in this art, which gives employment to ſuch numbers in this country.

THE moſt expenſive materials employed in bleaching, and which merit our firſt attention, are *Salts*, the properties of which ſhall be firſt conſidered in general, and then each of them in particular.

SALTS,

SALTS.

Salts may be defined to be ſubſtances fuſible in water, volatile, ſapid, and inflamable.

No doubt the definition may be objected to; and, it may be ſaid, there are other bodies poſſeſſed of ſome of theſe qualities: perhaps, however, there are no bodies, ſalts excepted, which will anſwer to all or one of the diſtinguiſhing characters given in ſo eminent a degree. Salts are ſaid to be fuſible in water, and volatile; however this is not to be underſtood, as if meaning, that they did not differ in degree in both of theſe particulars. Some of them attract water ſo ſtrongly, that it is difficult to prevent them from deliquating in the common temperature of the air: others again are ſo fixed, that we cannot procure veſſels capable of ſtanding degrees of heat ſufficient to evaporate them (earthen veſſels excepted); and, as ſoon as the ſalts fuſe in theſe veſſels, they act upon them, and ſo eſcape.

WE are not, however, on this account, to look upon them as entirely fixed, for it is probable, if we could procure veſſels of ſufficient ſtrength to ſtand the heat, that even the moſt refractory of them would be volatilized, and aſſume a vapouriſh appearance. Salts are alſo ſaid to be inflamable: this muſt be underſtood in a limited ſenſe however, becauſe ſome ſalts, as common ſea-ſalt, ſugar, &c. are inflamable; but perhaps ſuch of them as are ſo, derive this quality from an improper principle which they contain: though it is certain, ſalts are ſometimes inflamable, yet ſuch of them as are moſt pure, do not contain the principle of inflamability. Notwithſtanding all the varieties, which appear in the diſtinguiſhing marks of ſaline bodies, yet, perhaps, the definition is as perfect, as the nature of the ſubject will admit.

Some have endeavoured, to diſtinguiſh ſalts by their particular taſtes; nay, they have gone ſo far as to derive all taſte in bodies, from a quantity of ſalt in their compoſition; but it is evident that this is not the caſe; becauſe every body which has taſte, could not be diſtinguiſhed from a ſaline body.

Salts, in their pureſt ſtate, are ſemitranſparent ſubſtances, whitiſh, and brittle; to procure a ſalt in this manner, it muſt be melted, and allowed to cool again.

THE denſeſt ſtate of the ſalt is, when it is fluid; this may be proved by throwing a cake of ſalt-petre into a quantity of the ſame ſalt infuſion; in this the cake will ſwim, and it would ſeem from its being opake, that air gets in between the particles of it, which keeps them at a certain diſtance from each other; and thus by the particles of air cauſing a reflection and refraction, the ſemitranſparency only remains, not a perfect tranſparency, as when the ſalts are in a ſtate of perfect fuſion.

WHEN by any means, we can ſeparate the watery particles from a ſalt, we reduce it into a very fine powder.

SOME ſalts are very difficultly kept from fuſion; whilſt others will hardly evaporate or fuſe. Expoſe ſome ſalts to the common temperature of the air, and they evaporate; whilſt others require great heat; hence the diviſion into *volatile*, and *fixed* ſalts.

In order to fuſe volatile ſalts, they muſt be confined in cloſe veſſels, otherwiſe the heat neceſſary to their fuſion, will evaporate them.

Having thus taken a ſhort view of the relations of ſalts to fire; we ſhall now conſider their relations with reſpect to water.

All ſalts are ſoluble in water, ſome of them have a greater, ſome a leſſer attraction for water; ſome of them have ſo great an attraction for it, that it is impoſſible to preſerve them free of it; the reaſon of this is, that air is a ſolvent of water, in the ſame manner that water is a ſolvent of ſalt, and therefore the greateſt heat will not entirely free the air from its water.

SOME ſalts, when expoſed to the temperature of a warm room, attract the moiſture of the air, and diſſolve, whilſt others require the moiſture of a damp cellar.

SUCH ſalts, as melt in this manner, are called, DELIQUESCENT SALTS.

THERE are ſome very curious phenomena attending the mixture of ſalts and water.

I. EVERY one muſt have obſerved, that a ſort of milky appearance follows the mixture, which continues for ſome time, and then ceaſes; this we eaſily ſee, is owing to the aſcent of little air bubbles: although this appearance is of little importance, yet it is not improper to mention it, and to enquire into the cauſe of it; which appears to be this: There is a certain quantity of air contained in both, but when the ſalt and water are united, they, having a greater attraction for each other than for the air in their compoſitions, unite; in conſequence of which, the air is ſet looſe, and in its aſcent gives the whole that turbid, milky appearance; that this is the caſe appears from the following facts. If the water be boiled, and by this means deprived of a quantity of its air, the ſolution will not appear ſo turbid, nor ſo many bubbles ariſe; but, if the air be entirely extracted from the water, by the air-pump, it has ſtill leſs of this milky appearance; and were it not for that contained in the ſalt, in all probability, we would not have the ſmalleſt ſymptom of this appearance.

II. THE Second Phenomenon attending the mixture of ſalt and water, is a change of temperature.

WHEN a certain quantity of water is thrown upon ſalt, the temperature is raiſed; but when a greater quantity than this ſtated proportion, the mixture is always cooled, or ſunk in its temperature.

IT will hold univerſally, that when there is a true chemical mixture (which takes place in the firſt caſe) there is always * heat produced, and when there is mere ſolution, cold is produced.

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* Dr. Black's ingenious Doctrine of Latent Heat will account for this in a beautiful manner.

III. The third phenomenon that occurs in mixing ſalts with water, is, that when a certain quantity of ſalt is thrown into water, the ſalt diſappears, and is completely diſſolved; another quantity of ſalt will perhaps be alſo diſſolved, until at length we come to put in ſo much, that it falls to the bottom without being attracted by the water; when the water has got as much as it is capable of diſſolving, it is ſaid to be ſaturated.

It muſt be obſerved, however, that this ſaturation takes place only with the water, and not with the ſalt, for we may add any quantity of water to a ſaturated ſolution, and the ſalt will be equally diffuſed through the whole.

WHEN the ſaturation is not mutual, the chemiſts call it *ſimple ſolution*, to diſtinguiſh it from true chemical combination, when there is a real ſaturation on both ſides.

IN all caſes where the ſaturation is not mutual, we will find that it is affected by heat, and when the ſaturated mixture is heated, it is capable of taking up a greater quantity of ſalt, which, as it gradually cools, it lets go again in leſſer and leſſer degrees of heat, until it arrives at the freezing point.

COMMON ſea-ſalt is very little affected in its ſaturation by heat.

WHEN water is at the boiling temperature, that is 212° of Farrenheit, it will take up about four times as much ſaltpetre as common ſalt; and again, when it is cooled, it will take up about three times as much common ſalt as ſalt-petre.

It may be alſo obſerved, that when water is fully ſaturated with one ſalt, it will take up a quantity of another; and when it gets this other, it will be found to diſſolve a freſh quantity of the firſt; thus, an ounce of water is only able to diſſolve about 10 grains of corroſive ſublimate; but if it be mixed with a ſolution of ſal ammoniac, it will diſſolve 200 grains of the ſublimate. (For the proportions of ſalts diſſolved in this way, conſult Boerhaave, Newman, &c.)

The diſtribution of the particles of a ſalt in a fluid, muſt be at the angles of ſolid equilateral triangles; becauſe thus it is only, that the particles can be equidiſtant from each other.

IT muſt be obſerved, that to promote a ſolution of ſalts quickly in water, agitation muſt be uſed, for if ſalts be put into water, and no agitation uſed, their ſolution goes on very ſlowly, as may be proved by pouring a quantity of ſome limpid liquor, upon a tingid ſalt, and the colour will be obſerved to ariſe gradually to the top, until the whole is obſerved to be of an uniform colour ; which may be weeks, nay months before this happens ; but when the ſalt is once diſſolved, the water will never let it go again.

SEPARATION

OF

SALTS FROM WATER.

THE ſeparation of ſalts from water, is effected by means of heat, and this in two ways.

FIRST, If the ſalts are of a more fixed nature than water, the water is evaporated by a ſudden and continued heat, until all is gone off: this is called *evaporation to dryneſs*, and here there is an irregular lump of ſalt produced; in this way the common table, or ſea-ſalt is manufactured.

SECONDLY, When the ſalts are more volatile than water, the ſeparation is cauſed by evaporating with a ſlow, or gradual heat; and when the ſalts begin to evaporate, remove the ſolution to a cold place, where the ſalt continues to ſeparate as the liquor cools, until it be perfectly cold, and then no more will fall to the bottom; upon this the ſalt is to be carefully ſeparated, and the ſolution ſubmitted to a ſecond operation.

THERE is a curious Phenomenon attending this laſt method, which is, that the ſalt thus ſeparated, is diſpoſed to aſſume ſome regular and uniform appearance; when this is the effect, it is called CHRYSTALIZATION, and each particular ſalt is diſpoſed to run into chryſtals of a particular form; ſo that a perſon acquainted with ſalts, can diſtinguiſh each of them by their particular ſhape; however this is not a very exact way of diſtinguiſhing them.

It is very remarkable, that if the chryſtalization is performed in wide veſſels, the chryſtals riſe at the ſides of the veſſel, one above another by capillary attraction, and go over the lips of the veſſel, and forms various branches, and curious ramifications; this is called efloreſcence, or chemical vegitation: great quantities of ſalts, are often by negligence loſt in this way.

As the phenomenon of the chryſtalization of ſalts is very curious, ſo there have been many attempts made to explain it.

SOME, as *Becher*, ſuppoſed that the forms of the chryſtals were the ſame with that of the original atoms of the ſalt, and then always the chryſtals of ſalts were a congregation of a number of theſe atoms in that form, in which the ultimate elements themſelves were. This is mere fancy and hypotheſis, built upon conjecture; for, admitting there were theſe forms, it will not account for the various forms of chryſtals; for only a very few number of figures can be united, ſo as to produce a figure exactly of the ſame ſhape; when a number of hexagons are laid down over each other, they will produce a regular figure of the ſame ſhape; the ſame will follow from the union of cubes, triangles, and a very few other figures, as is well known to mathematicians.

BUT as chryſtals of ſalts contain water, which prevent their parts from coming into contact, it doth not matter what ſhape or figure their elementary particles be, beſides chryſtalization is not peculiar to ſalts, water chryſtalizes, metals alſo chryſtalize, as may be ſeen by breaking a piece of metal.

Some have attributed this to the different volatility and fixity of ſalts.

Some have introduced a ſeminal principle into ſalts, juſt as in plants; but this is whimſical, and improbable, not worth taking notice of.

Sir *Iſaac Newton* obſerving, that in a ſolution of ſalt in water, the particles muſt be at the angles of ſolid equilateral triangles, he ſuppoſes, that when the water is evaporated, theſe particles come nearer and nearer, until at length, the water having left them, they land in an abſolute contact: and theſe triangles being united, there is formed a chryſtal, which he endeavours to prove by a ſtrong mathematical judgement, are reducible to triangles of which they are compoſed; that is, reſemble in their forms what would be made up of ſuch triangles: but, was this the caſe, it would ſeem very probable, that the ſalt would be all at once gathered into one maſs, and not into gradually formed, and regular chryſtals.

HERE *Doctor Stahl* brings in his doctrine of affinities between the particles of bodies; but this is merely an hypotheſis, built purely upon another.

ANOTHER hypotheſis, is that of Mr. *Muſſchenbroek*, who ſuppoſes that there is a ſort of polarity in the particles of ſalt, by which they are regularly attracted, juſt as when ſeveral magnetic needles are placed upon the ſurface of water, within the ſpheres of each others attraction, they come together, and have a tendency to form a regular maſs or figure, the ſouth pole of one, attracting the north pole of the other.

This hypotheſis is very ingenious, and is found to account for many, perhaps all the phenomena which take place in the chryſtalizations of ſalts, metals, water, &c. and ſhould be adopted before any other hypothetical account.

As I am upon the ſubject of chryſtalization, I ſhall take notice of what happens in the freezing of water.

If a baſon of water is expoſed to air, at the freezing point (*i.e.* 32 of Far. ther.) the firſt ice will be obſerved to ſhoot in oblong maſſes from the edge towards the center of the baſon; and ſmall maſſes will ſhoot from the larger ones, preciſely at the ſame angle, that is, an angle of 60 degrees; this I think was firſt obſerved by Mr. Miran, and ſeems to ſtrengthen Mr. Muſſchenbroek's theory of chryſtalization.

THE enquiry into the cauſe of this phenomena is not very material; it was proper however to take notice of it, that, by reading books on this ſubject, there might be leſs danger of adopting miſtaken notions on the matter.

IT muſt be obſerved, that ſalts are not to be claſſed according to their external appearance, as many ſalts that have the ſame general form, have different chemical properties; and many differing in ſenſible form, have the ſame chemical properties;

perties; they muſt therefore be examined by means of *heat* and *mixture*.

SALTS are either ſimple or compound. I ſhall go on with the conſideration of the properties of ſimple ſalts, and ſhall take very little notice of compound ſalts, as they are of little uſe to the bleacher.

SIMPLE ſalts are not numerous; they may be reduced to theſe two claſſes, *alkalies* and *acids*, and whenever a ſaline body is examined, it will be found compoſed,

FIRST,

Entirely of an alkali; or,

SECONDLY,

Of an acid; or,

THIRDLY,

Of an alkali combined with ſome other ſubſtance; or,

LASTLY,

LASTLY,

Of an acid combined with ſome other ſubſtance.

THE firſt that ſhall be conſidered are alkalies.

ALKALI.

ALKALI.

THE ſimple properties of this ſalt are, that it diſſolves in water, like ſalts in general: that it changes purple and blue colours, either into a green, or making the blue deeper, by deſtroying the purple tinge; as when it is put into an infuſion of violets, &c. this effect is diſcovered, and this is a peculiar diſtinguiſhing property of alkalies; ſo when bodies are mixed together, and upon the addition of a vegetable infuſion, there is a green colour produced; it may be concluded, that the mixture contains leſs or more of an alkaline ſalt, according to the deepneſs of the colour produced.

WHEN it is required to know preciſely whether there is an alkali in any mixture, ſlips of paper tinged of a purple colour, by means of the infuſion of violets, are uſed, and by dipping the ends of them into a mixture, where an alkali is ſuſpected, the variation of colour will be ſenſible on the paper, if ſuch is produced: theſe are called *teſt-papers*, and may be kept always ready in a phial cloſely ſtopped. That tinged with the bark of radiſhes, is the beſt for diſtinguiſhing acids.

WHEN alkalies are mixed with other bodies, and ſqueezed between the fingers, it produces a ſort of ſoapy toughneſs, ſomewhat oily; when pure, they are of ſo corroſive and acrid a nature, that they cannot be applied with ſafety to the ſkin; when they are taſted as diſſolved in water, they affect the tongue with a conſiderable degree of acrimony and pungency; on this account they are noted detirgents, taking away greaſe, and other ſordes from the cloth; on this account they are uſed in bleaching.

Alkalies differ much in their degree of volatility, ſome cannot be volatilized by the utmoſt ſkill of the chemiſt.

So volatile again are ſome others, that they cannot, without a good deal of trouble, be kept in a ſolid form, or preſerved from flying off in vapour; hence alkalies are divided into fixed and volatile. Of the fixed, there are two kinds, named from the manner in which they are procured, viz. from earth and from vegetables; hence the diviſion into *fixed foſſil*, and *fixed vegetable alkalies*.

First,

FIRST.

Fixed foſſil Alkali.

THIS ſalt is extremely fixed; it differs in reſpect of purity, and alſo in its eaſineſs of ſolution in water; it may be chryſtalized like other ſalts, and its chryſtals, when they begin to ſhoot, ſtand erect in the water; when its chryſtals are pure, they keep dry, and do not deliquate.

THE foſſil alkali is found in its pure ſtate, in many parts of the world, particularly in Egypt, about the banks of the Euxine, and Caſpian ſeas, as alſo at Teneriff, where it is found lying upon the ſurface of the earth in conſiderable thickneſs; it is alſo found upon old walls in this country.

The *natrum* of the ancients is what is found upon the ground in its pure ſtate.

The greateſt quantities of it are obtained from native ſalts, particularly the common ſea-ſalt.

It is obtained in conſiderable quantities from the aſhes of marine vegetables, particularly the kali [*], and ſea-rack, of which the kelp is made; the kelp, in its common ſtate, contains many impurities, which may be ſeparated from it by ſolution in water, and chryſtalization, burning, &c.

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[*] It is ſaid that alkalies have their name from this plant.

SECOND.

Fixed vegetable Alkali.

THIS ſalt is chiefly diſtinguiſhed from the foſſil, by its more acrid taſte, and it deliquates when expoſed to the open air; it requires the heat of a reverberating furnace to melt it.

IT is very remarkable, that when this ſalt is mixed with water, the mixture does not boil under 250 degrees of Farrenheit's thermometer, whereas water boils at 212 degrees.

THE chemiſts have fallen into a miſtake with regard to this ſalt, by ſuppoſing that it is not capable of chryſtalization; for it is found to chryſtalize when in a mild ſtate.

THERE is but one native ſalt that contains the fixed vegetable alkali in its compoſition, viz. Nitre.

THIS fixed vegetable alkali is found in the aſhes of moſt plants; the reſinous and odorous yield but ſmall quantities of it.

IT has obtained many different names, which ſee in pages 66, 67.

THIRD.

The volatile Alkali.

ALTHOUGH this alkali cannot be uſed in bleaching, on account of its volatility, yet, as it is the only remaining alkali, I ſhall give a ſhort account of it; as I think it is neceſſary the bleacher ſhould have a comparative view of alkalies.

It differs nothing in its general qualities from the fixed alkali, viz. in its taſte, effect upon vegetable colours, acrimony, &c. It differs from them, however, in its relation to heat; it evaporizes in the common temperature of the air, and loſes its properties entirely if expoſed to it; on account of which, it cannot be uſed in bleaching, as I ſaid above.

It is obtained from the ſoot of pit-coal; it is alſo obtained from the embers of rubbiſh, or burned matter; alſo in conſiderable quantities from all putrid ſubſtances; it is alſo obtained from the ſeeds of thoſe plants which have a pungent, acrid taſte, as muſtard, horſe-radiſh, &c.

Animal ſubſtances give it in great plenty, particularly their hard and ſolid parts, as bones, horns, hoofs, &c. It is alſo obtained from all the fluid parts of animals, as urine and blood, when in a putrid ſtate.

It has been found, that the fixed alkali, by proper treatment, is convertable into the volatile; and indeed it ſeems to be nothing elſe but the fixed alkali, ſome way united with the principle of inflammability.

This alkali is chiefly uſed in medicine; that obtained from putrid urine, is uſed in ſcouring ſilks, wool, &c.

ACIDS.

ACIDS.

ACIDS are generally diſtinguiſhed by their ſour, ſharp taſte, from which they have their name; but the beſt way of diſtinguiſhing them is, by their effects upon vegetable colours. Alkalies deepen colours; they, on the contrary, lighten them; they change a purple into a red, and a blue into a dark purple. To diſtinguiſh the colour more accurately, teſt-paper, (which I formerly mentioned, page 38) is uſed; paper, tinged with the bark of radiſhes, does beſt for diſcovering an acid in a mixture; with violets, for diſcovering an alkali.

ACIDS unite ſtrongly with alkalies, and from ſuch an union, their reſpective qualities are changed.

No ſubſtance, except acids, effervefces with alkalies, and from the combination of theſe there reſults a compound ſalt, the conſideration of which would be of little ſervice to our preſent purpoſe.

Acids are fuſible and volatile, have a great attraction for water, and mix with it as all ſalts do.

Acids are obtained from both foſſil and vegetable ſubſtances; but thoſe which poſſeſs it in a more eminent degree, are the mineral acids, theſe are the *vitriolic*, *nitrous*, and *muriatic*.

So great is the attraction of acids for water, that we cannot get them in a ſolid form. I ſhall leave philoſophers to determine, whether ſolidity or fluidity be their natural form.

The

The vitriolic Acid.

AS to the diſtinguiſhing properties of the vitriolic acid, as it is obtained from vitriol, or coperas, from whence it has its name: this vitriol conſiſts of iron united with the acid, it is decompoſed, and the acid obtained by diſtillation; when we thus obtain it, it is a colourleſs, tranſparent fluid; it is, when pure, very heavy; of all fluids it is next in weight to mercury; the proportion of the weight of water to it, is 10 to 18; that is, a veſſel containing about 10 ounces of water, will hold 18 ounces of it. It is probable, it contains more ſalt than any other acid.

As to its properties with reſpect to heat, it expands very much; if bottles be filled quite full of it in the winter, and put to keep, they will infallibly burſt by the ſummer's heat; hence a caution to leave a ſmall ſpace of the bottle empty, that thereby the dangerous conſequences, of its burſting and ſcattering among other ſubſtances may be avoided.

It requires 550 degrees of Farrenheit's thermometer to boil it, which is a greater heat than is neceſſary to boil any of the other acids; hence it is ſtronger than any of the other acids: the vapours that ariſe from it in boiling are extremely dangerous.

The vitriolic acid, of all others, has the ſtrongeſt attraction for water, nay, ſtronger than all bodies whatever; in conſequence of which, when mixed with water, there is always heat; but when mixed with ice or ſnow, there is always cold produced.

WHEN 18 parts of vitriolic acid are mixed with 32 parts of water, there is a diminution of bulk; the whole ſhould be 50, whereas it is only 49.

THE watery vapours of the air attract it, as it attracts them; ſo that the air, in the neighbourhood of vitriolic acid manufactories, will be found to change vegetable colours.

THE attraction of the moiſt particles of the air, and of it for them, are mutual.

WHEN a quantity of it is expoſed in the common temperature of a room, it is found to abſorb one-third its weight in a day; and the longer it is expoſed, its attraction for the moiſture is the weaker. When thus expoſed for one year, it is found to abſorb about ſix and an half times its weight, which is twelve times its bulk.

As to its other attractions, it hath a greater attraction for alkalies than for any other ſubſtance, except phlogiſton; and its attraction for fixed *alkali* is greater than for volatile alkali.

The Chemiſts have given many marks, to know when, this acid is in its pureſt ſtate, as that it is tranſparent and colourleſs; however the ſtrongeſt kind, when it is expoſed to the air, turns black.

It is alſo ſaid, that when inflammable ſubſtances are put into it (as a feather, or the like) it will be blackened: this effect, however, will be produced, when it is much weaker than in its pureſt ſtate.

THE beſt way, however, of aſcertaining its purity, is by comparing its weight with water, which is in the proportion of 18 to 10, as I ſaid before.

As it will particularly anſwer our preſent purpoſe, to underſtand the relation of this acid to the phlogiſton*, Dr. Stahl's experiments are moſt fitly recommended.

THIS acid hath a greater attraction for the phlogiſton than for any other body whatever; ſo much, that when it is mixed with oil, there is produced a fume, with a conſiderable degree of heat, and a pitchy darkneſs, reſembling tar.

IF inſtead of pouring the acid on the inflammable matter, or oil, we let a drop of oil fall upon the acid, it ſpreads over the ſurface in a brown coffee colour, which is juſt owing to the mixture, with the principle of inflammability.

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* Phlogiſton, and the principle of inflammability are ſynonimous terms.

If the duſt of the room can have acceſs to it, or if the bottle be ſhut with a ſtopper of cork-wood, the phlogiſton, in the particles of duſt, or in the cork-wood, will give it a brown colour, to free it of which it may be boiled; by which operation it is always reduced to its primitive tranſparent colour.

If oil of turpentine be mixed with this acid, the ſame brownneſs is produced; and when the mixture is diſtilled, there remains in the bottom of the retort a quantity of the acid and oil, in a dry ſtate, and from their union form brimſtone, which is compounded of the vitriolic acid and the phlogiſton of the oil, in a dry ſtate. Accordingly, when brimſtone is burned under a glaſs veſſel, and the fumes caught, it is the vitriolic acid that is obtained, and it is in this manner that we are ſupplied with ſuch large quantities of it.

In the common proceſſes for obtaining the vitriolic acid from ſulphur, the quantity of acid obtained is greater in weight than the ſulphur from which it is procured. In common manufactories, from 16 pounds weight of ſulphur there is commonly obtained 22 or 23 pounds of the acid, beſides the many fumes which are loſt in the operation, which cannot be preſerved. It appears, therefore, that the phlogiſton diminiſhes the weight of bodies into which it enters.

This acid has ſo great an attraction for water, and for every body almoſt that it meets with, that it is impoſſible to ſuppoſe it exiſting in the bowels of the earth, in a pure form.

It is found in many compounds of the earths, from which it may be eaſily procured; gypſum, or alabaſter, affords great quantities of it; there is alſo great quantities of it in allum.

It is alſo to be procured from all earths; but ſulphur is the great ſource from which it is always extracted; alſo from white, blue, and green vitriol, which may be proved to be a compoſition, containing ſulphur: we find it in all minerals, becauſe they all contain ſulphur.

It is alſo obtained from the aſhes of vegetables; becauſe all plants have in their compoſition a quantity of this acid and alkali; and by the action of the fire, being ſet looſe from the plants, unite, and attract a portion of the phlogiſton from the vegetable, and thus enter their aſhes in form of an * *hepar ſulphuris.*

KELP ſmells ſtrongly of the hepar ſulphuris.

THIS acid is floating in the atmoſphere in a volatile ſtate (although ſome of the moſt reputable chemiſts alledge the contrary); but it is plain, from the ſmelting of ores, &c. that what is decompoſed in this operation is the ſulphureous part from the pure metal; the ſulphur is completely deſtroyed, and the vapour of the acid aſcends into the air.

SOME chemiſts have alſo ſuppoſed that it ſubſiſted in the electrical atmoſphere:

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* *Hepar ſulphuris* (ſo called from its reſemblance to liver) is made by putting a quantity of fixed alkali and ſulphur into a crucible, and fuſing them.

this they prove from the reſemblance of the taſtes to each other; ſecondly, from the ſulphureous ſmell which is often found in the electrical atmoſphere; and, thirdly, from its effect in changing the roſe and other vegetable colours.

But the fallacy of theſe arguments ſhall be ſhewn hereafter.

This acid diſſolves iron, zinc, and copper, and can be united with all the metals when boiling hot.

The great uſe of the vitriolic acid in bleaching, ſeems to depend upon its great degree of attraction for the phlogiſton. All vegetables, as flax, hemp, &c. of which cloth are made, contain a quantity of colouring matter, known by the name of *ſea-green*, and this is found to contain much more of the phlogiſton than the pure fibrous part of the flax doth; and it is owing to its ſuperior attraction for, and action upon, this ſubſtance, that it is of ſuch ſervice in whitening the cloth; which is contrary to the opinions of Drs. Home*, Ferguſon†, and M'Bride, who ſay that its principal uſe is in freeing the linen from an earthy matter, that is let down on it from the alkaline lees. But more of this when I come to treat of the operations on bleaching.

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[*] See Home on Bleaching.

[†] Dr. Ferguſon's experimental Eſſays on the uſe of lees and ſours in bleaching; alſo Dr. M'Bride's abſtract of it.

NITROUS ACID.

THE nitrous acid has been uſed in bleaching; yet it does not anſwer the purpoſe ſo well as the vitriolic, on account of ſome properties which I ſhall take notice of immediately.

THIS acid hath obtained its name from nitre, or ſalt-petre, from which it is generally obtained.

IT differs from the vitriolic acid in this, that it is of a deep orange colour, and emits ſtrong viſible elaſtic fumes, which tinge the ſides of the bottle of an orange colour.

It boils at 240 degrees of Farrenheit's thermometer; whereas water boils at 212 degrees. It is next to the vitriolic acid, in ſpecific gravity.

The attractions of this acid are nearly the ſame with the vitriolic acid.

Its attraction for the phlogiſton, tho' generally ſuppoſed by ſome of the moſt eminent chemiſts ſtronger than that of the vitriolic acid, is not however the caſe, as appears from its not being able to decompoſe ſulphur; on the contrary, when the nitrous acid is united to the principle of inflammability, that the vitriolic acid will decompoſe the mixture, and the nitrous acid will be precipitated; on this account therefore it is not equal to the vitriolic acid in bleaching, according to the theory, which I ſhall explain hereafter.

As to its origin, the ſtrongeſt acid is got from diſtilling a mixture of the ſtrongeſt vitriolic acid with nitre; when it is ſo much diluted with water, as to diſſolve one half its own weight of ſilver, it is called *aqua fortis*.

THIS acid diſſolves moſt metallic ſubſtances; it corrodes tin and antimony.

MURIATIC ACID.

THIS muriatic acid has got its name from *muriæ*, brine, becauſe it is produced chiefly from ſea-ſalt: it is generally of a pale yellow colour.

ITS ſpecific gravity to rain water is, as 13 to 10: it requires a greater heat to boil it than water doth. This acid is diſtinguiſhed from the other acids by its ſmell, which is not diſagreeable, rather inclining to a ſaffron ſmell.

IT has a weak action on inflammable ſubſtances. It has been thought by ſome, that it better anſwers the purpoſes of bleaching than the vitriolic acid, as it has not ſuch a tendency to deſtroy the cloth;

but experience ſhews us that it has inconveniences which the vitriolic acid hath not.

THIS ſalt is no where to be found in a pure and natural ſtate; common ſalt is its great matrix.

DOCTOR Stahl ſuppoſed that it might be changed into the vitriolic acid, and *vice verſa*, and conſequently that they were the ſame acid; but the experiments which he delivers are not convincive nor concluſive.

IT melts quick lime with great rapidity, and has a ſtrong attraction for alkalies. It is ſour in its taſte, acts upon vegetable colours as the other two acids do.

VEGETABLE ACIDS.

BESIDES theſe foſſil acids, there are the vegetable acids, which act on colours, mix with alkalies, and have all the properties of acids; but they are ſo weak and ſo mixed with heterogeneous ſubſtances, and ſo eaſily affected, and deſtroyed by heat, &c. that they will be of little ſervice to our preſent purpoſe: it is ſufficient for us to know that they are three in number.

I. NATIVE ACID, or ſuch as is obtained from lemons, and other pulpy fruits.

II. DISTILLED ACID, or ſuch as is procured from many plants by diſtillation.

III. ACETOUS ACID, or ſuch as is obtained from juices of a ſweet and ſaccharine nature, by fermentation.

THE latter of theſe were formerly uſed in bleaching, but they are now entirely laid aſide, by the more ſkilful bleachers.

I SHALL, for the preſent, leave off conſidering the properties of ſalts, until we become acquainted with the properties of ſome other bodies, neceſſary for our purpoſe.

I HAVE not compared or compounded ſalts with any other bodies, except ſuch as I thought neceſſary for a complete knowledge of our ſubject.

A TABLE, ſhewing the different TERM
modern, expreſſi

A L K A L I E S.

	SYNONYMA.	
Fixed foſſil Alkali,	Natrum, Nitrum Muriale, Soda, Bariglia, Kelp.	
Fixed vegetable Alkali,	Salt of Wormwood, Salt of Tartar, Fixed Nitre, Cineres clavelati GAL. Cendres gravillees, Ruſſian Aſhes, Pot Aſh, Pearl Aſh, Caſſob, Alkaheſt Glauberi, Marcoſt, Blanch Aſhes, Black Flux.	
	Ol. Tart. per deliq. Lixivium Tartari,	When diſſolved in Wat
Volatile Alkali,	Sal Ammon. volatilis, Salt of Hartſhorn, Salt of Urine,	
	Spirit of Sal Ammoniac, of Hartſhorn, of Soot, of Urine.	When diſſolved in W

be met with in Authors, both ancient and e ſame SALT.

ACIDS.

SYNONYMA.

Vitriolic Acid,	Oil of Vitriol, Spirit of Vitriol, Acid of Sulphur, Sp. Sulph. per Campan. Acidum Calcanthi, Primigenium, Catholicum, Univerſale, Acrum, Vagum Foſſile.
Nitrous Acid,	Spirit of Nitre, Sp. Nitri Glauberi, Aqua Fortis—when diluted with Water.
Muriatic Acid,	Spirit of Salt, Sp. Salis Glauberi.
Acetous Acid,	Diſtilled Vinegar, Spirit of Vinegar.

LIME.

AS lime is of ſo great uſe in bleaching, I ſhall conſider ſome of its moſt obvious properties.

QUICK lime is obtained from crude calcarious earths, (which ſee in the oppoſite page.)

THIS earth, in its reduction from a crude to a calcarious ſtate, loſes better than half its weight, and now has properties which it had not before; formerly it was mild and inſipid, now it is ſharp taſted, and more cauſtic than alkaline ſalts; when crude, it diſcovers no attraction for water, now it is eaſily diſſolved in it; and when

A

TABLE

OF

CALCARIOUS EARTHS.

- Pure Calcarious Earth,
  - Powdery, as Mineral Agaric,
  - Friable—Chalk,
  - Hard—Limeſtone and Marble,
  - Chryſtalized—Rhomboidal Spar
  - Precipitated—Stillactiles.
- Calcarious Earth mixed with
  - Vitriolic Acid gypſeous,
    - Flaky,
    - Fibrous ditto,
    - Granulated ditto,
    - Chryſtalized ditto.
  - Inflammable Matter,
    - Sow Stone,
    - Liver Stone.
  - Clay,—Marle.
  - Metals,—Semi Ores, and falſe Gems.
  - Animal Juices,
    - Shells of the incruſtaceous Kind,
    - Lythopyta.

when diſſolved in water, it raiſes the temperature very much; its heat is often ſo great upon the addition of water, as to ſet fire to ſome inflammable bodies. When a ſufficient quantity of water is added, there is no more heat produced; now called ſlacked lime, it is now in its chryſtaline form, the ſame as happens to ſalts; when chryſtalized, like them, it contains a quantity of water; theſe chryſtals can not be ſeen by the naked eye, but are clearly ſeen by the help of a microſcope.

WHEN ſaturated with water it reſembles alkalies in all its properties, it requires 1100 times its own weight of water to diſſolve it.

A FIXED alkali precipitates lime from lime water, in a powdry form, and the lime thus precipitated, is greatly changed in its properties; it has now loſt its fiery corroſive quality, and is reduced to a crude calcarious earth. The alkali likewiſe ſuffers very remarkable changes, and from being mild, and in a manner inactive, it is rendered very cauſtic and corroſive, ſo much ſo, that it has the ſame effect upon animal bodies as hot iron would; it alſo corrodes and deſtroys vegetable ſubſtances.

QUICK lime unites with acids, but does not efferveſce; whereas crude calcarious earth efferveſces with acids.

QUICK lime, when expoſed to the air, again grows mild, and is reduced to crude calcarious earth.

WHEN lime is expoſed to the air, it is ſlacked, as well as when water is thrown on it; but from theſe two different methods of ſlacking lime, there is one very ſingular phenomenon, that lime ſlacked in the air will efferveſce with acids, but that ſlacked with water will not.

WHEN lime water is expoſed to air in a broad ſurface, and evaporation takes place, the lime falls down to the bottom in form of a crude calcarious earth.

THUS, therefore, we ſee that quick lime may be recovered into crude calcarious earth, whether by adding an alkali to the lime water, or by expoſing it to the action of the air; and the earth thus produced, may again be reduced to a calx, by expoſure to heat, &c.

MANY have been the methods fallen upon to account for the phenomena concerning lime. Some ſuppoſe a certain ſubtle matter inherent in the lime, to be the cauſe of the various appearances; others ſuppoſe that the fire enters its pores, and the like; but the ingenious theories of Lemery, Alſton, Stahl, &c. are all of them imperfect and inconcluſive.

THE perfect knowledge of this matter, we owe to Doctor Black, to whoſe paper I refer the reader, (publiſhed in the *Edinburgh Medical Eſſays*) which is perhaps one of the beſt models in experimental philoſophy.

DOCTOR BLACK conſidered calcarious earth as a compoſition of lime and fixed air, and imagined that the cauſticity of lime, was owing to its want of fixed air; and when fixed air was added to a lime, it was always rendered mild and inactive; that is, a crude and calcarious earth: and he thought that the fixed air was ſo intimately combined with its earthly part, that nothing leſs than the ſtrong and long continued action of fire, was able to diſunite them.

WHEN calcarious earth is rendered cauſtic by fire, and openly expoſed, it firſt attracts ſo much moiſture from the air as is ſufficient to reduce it to a chryſtaline form; then it attracts fixed air, and by its union, is reduced to its original crude ſtate, entirely deſerting the water; as a proof of this we may obſerve, that when lime water is openly expoſed to the air, it gradually gathers a ſcum over its ſurface, which is nothing but a quantity of calx, from which the water has evaporated, and by its attraction for the air, is rendered mild, and reduced to a calcarious earth; this ſcum gradually thickens, as the evaporation continues, until it becomes

comes heavy enough to fall to the bottom, and the whole of the water evaporated, the whole quantity of the lime which was ſolved in it, will be found in the bottom, in form of a crude earth.

THE attraction of the lime for air is found to be ſtronger than that of alkali for air; the cauſticity of alkali ſeems to be its natural ſtate, and its mildneſs depends upon its union with fixed air. Such are the facts that much ſtrengthen Doctor Black's theory; but he has proved them another way, that is by attending to the conſequences that muſt follow, provided his theory be juſt, which he has reduced to ſeven, (which ſee in his paper mentioned above) in which he has not only proved, by direct experiment, but this explained, eaſily ſolves all the phenomena that are produced by air, that is, that air makes a principle in many bodies; that it is contained in magneſia; that limes are ſoluble in water, when free from it, and inſoluble when they contain it; and that alkalies are made cauſtic by being freed from their fixed air, by the addition of quick lime, for which it has a ſtronger attraction.

THE order of fixed air's attractions are ſeen in the following table.

FIXED AIR.	ACIDS.
1. Quick Lime.	1. Fixed Alkali and Quick Lime.
2. Fixed Alkali.	
3. Magneſia.	2. Volatile Alkali and Magneſia.
4. Volatile Alkali.	

First, It hath the greateſt attraction for quick lime, next for fixed alkali, then for magneſia, and volatile alkali.

Acids have the greateſt attraction for fixed alkali; and quick lime, then equally for volatile alkali and magneſia.

Although I have fully treated of the properties of the ſimple ſalts and lime, yet I ſhall deliver a few ſhort methods, by which the ſtrength and comparative value of all alkaline aſhes may be known.

FIRST METHOD.

Take equal weights of each of the different alkaline aſhes ſeparately, which you intend to compare, and put each of them into as much water as is capable of diſſolving the ſalts; ſuch of them as do not readily yield their ſalts, muſt be boiled, then pour off each of theſe ſolutions, into glaſs veſſels, that thereby we may get rid of their earthy parts; then drop into each of theſe ſolutions as much vitriolic acid, diluted with half its weight of water, as will neutralize them, which can be diſcovered by the vegetable infuſions, or rather the teſt-papers already mentioned; for if the end of the paper, when wetted in the ſolution, inclines to red, too much acid has been added; but if to a green, there is not enough added; ſo we muſt drop in as much, and no more, than that thereby the colour of the paper may not be altered; in this caſe it is a neutral ſalt, and that alkali which requires the greateſt number of acid drops to neutralize it, is the ſtronger, and in proportion to the greater quantity of acid employed.

SECOND METHOD.

THE proportion of ſalts they contain, may be known by evaporating each of the ſolutions.

THIRD METHOD.

IF we take equal weights of the aſhes, and diſſolve them in equal quantities of water ſeparately, we can know what proportion they bear to each other, in reſpect of their ſalts, by comparing their different ſpecific gravities, which may be done by the hydroſtatical ball.

THESE are general methods, to know the comparative values of all alkaline aſhes, which will render it unneceſſary in this place to conſider the qualities of the different aſhes uſed in bleaching; as many of the ſame ſpecies differ much in the quantity of ſalt they contain.

I MUST here obſerve, that Dr. Home is miſtaken, who, along with Boerhaave, aſſerts, that efferveſcence with acids is the only true teſt of alkalies; for calcarious earth will efferveſce with acids; and alkalies, when in their ſtrongeſt ſtate, will not efferveſce with acids.

THE method to know what quantity of fixed air is contained in the different alkalies, is clearly ſhewn by Dr. Black, in his Explanation of the Effect of Lime upon Alkaline Salts, which paſſage I ſhall quote.

" TAKE ſuch a quantity of each lee
" ſeparately, as contains half an ounce of
" ſalt; put it into a florentine flaſk, ſet

" the flaſk upon one of the ſcales of a
" good and properly ſuſpended balance,
" and, along with the flaſk, in the ſame
" ſcale, ſet a little phial containing an
" ounce or two of a mixture of equal
" parts of vitriolic acid and water; when
" things are in this ſituation, put a quan-
" tity of ſand, or other matter, into the
" oppoſite ſcale, until an exact equili-
" brium be obtained, and then taking off
" the flaſk and the phial, pour in the acid
" into the flaſk, by ſmall quantities at a
" time, ſhaking the flaſk after every ad-
" dition, until there be no more ebulli-
" tion, upon adding more of the acid:
" and now, replacing the flaſk and phial
" in the ſame ſcale, obſerve how many
" grains weight muſt be put into the ſcale,
" to reſtore the equilibrium, which has
" been attracted by the expulſion and diſ-
" ſipation of the mephitic air; it is obvi-
" ous that the number of theſe grains

" will be in proportion to the quantity
" of air which was attracted to the
" ſalt."

THE alkali and acid, having a ſtronger attraction for each other, unite; in conſequence of which, the air is ſet looſe, and cauſes an efferveſcence.

SOME of theſe alkaline aſhes contain no leſs than 36 and 37 pound of air in the hundred weight.

BUT this fixed air is ſeparated from alkalies by means of quick lime, for the purpoſes of bleaching; and, in this caſe, there is no efferveſcence; the air uniting with the lime, falls to the bottom of the lixive.

OTHERS of theſe aſhes, again, contain little or none of this air, on account of the quantity of lime in their compoſition.

As the mildneſs of fixed alkali and calcarious earth, depends upon air adhering to them, and to make them cauſtic, we need only ſeparate the air; it has been thought, that the ſame degree of heat that is ſufficient to convert the calcarious earth into quick lime, ſhould reduce the fixed alkali to a ſtate of perfect cauſticity, the calcarious earth having a ſtronger attraction for fixed air, than the fixed alkali has; but it appears from experience, that it cannot be made perfectly cauſtic by heat: the reaſon of which is this; although fixed alkali is capable of enduring a conſiderable degree of heat, it will not approach to the degree that is neceſſary to the calcination of calcarious earth, part of it is converted into vapour, and the reſt corrodes the veſſel, and is loſt; beſides, it

is

is well known to the chemiſts, that the fuſion the ſalt undergoes, is an obſtacle to the ſeparation of the volatile from the fixed parts by heat.

THE alkaline ſalts do, however, acquire a very ſenſible degree of cauſticity, from being expoſed to ſtrong heat.

WATER.

WATER.

AS a good choice of water is of the greateſt conſequence to the bleacher, I therefore, in my firſt plan of this treatiſe, intended to have firſt conſidered its properties, and, from a knowledge of it, to have conſidered the properties of other bodies, ſuch as ſalts, &c. employed in bleaching: but I found, that by giving ſuch a view of it, I would have been led to conſider it in a very philoſophic manner; ſuch as, whether ſolidity or fluidity was its natural ſtate; its ſuppoſed incompreſſibility, its evaporation by heat; as alſo to conſider it as the great agent employed to arrange and diſpoſe many of the bodies in nature, as the numerous tribes of vegetables and animals, earths, ſtones, &c. and indeed marble, limeſtone, chalk, &

&c. which are manifeſtly compoſed of ſhells, corals, and the like, ſhew that nothing elſe than water could have diſpoſed them in this manner.

THE ſtrata of freeſtone ſhew evident marks of the action of water.

SOME have gone ſo far as to prove, that water even furniſhed the materials, by obſerving, that it was convertible into earth; which was firſt advanced by Van Helmont. Mr. Boyle was alſo of the ſame opinion, and ſays he obtained earth in conſiderable quantity from water, by diſtillation; although Boerhaave denies this fact, and ſuppoſes the earth thus obtained was the duſt of the room; but the more accurate experiments of Margraaf and Newman ſhew, that water is convertible into earth.

Mr. Margraaf, ſeeing the ſtate of the caſe between Boerhaave and his predeceſſors, was led to try the fact, with the greateſt caution poſſible: he made the experiment with the pureſt rain water, and with ſnow, which for accuracy, we are told, was diſtilled ten times before it was employed to the experiment; and he found that even then, after careful diſtillation, he procured earth, which, when examined, was a white inſipid ſubſtance, not the leaſt reſembling any duſt that might be had in the room where the experiment was made.

But if this earth was owing to the duſt in the room, it muſt have followed, that when the experiment was made ſlowly, and in open veſſels, the greateſt quantity would have been procured; whereas the contrary was the caſe: and it was found, that the experiment carried on ſuddenly, and in cloſe veſſels, produced the greateſt quantities of earth. But leaſt there ſhould ſtill be a doubt made, Mr. Margraaf procured a retort and receiver, made in one piece; and having thus carried on the experiment, every time, he had always obtained a new quantity of earth, and he ſuppoſed that at laſt he would have reduced the water altogether to earth, had not a crack in his glaſſes prevented the further proſecution of the experiment.

SUCH were the precautions uſed by Mr. Margraaf, and ſuch his concluſions.

FROM all theſe facts it is ſufficiently clear, that earth is obtained from water.

WATER is alſo convertible into earth by agitation, viz. when it is cloſed up in a ſtaunch veſſel, and much agitated, as by faſtening it to the clapper of a mill.

EARTH is alſo obtained from water by trituration; as when we put a quantity of it into a mortar, and pound it as it were, we get from it a conſiderable quantity of earth.

BUT it is now natural to enquire, how it is combined with water. It is not by diffuſion; becauſe ſo great a quantity could not be diffuſed as ſome have procured, three-fourths of its whole weight, and others a much larger quantity; beſides, at the firſt diſtillation the greater quantity ſhould be obtained, on account of the great difference of volatility between the earth and water; but, on the contrary, more is obtained in the ſecond operation than in the firſt; and more in the third than the ſecond.

IT cannot be combined by ſolution; becauſe ſo great a quantity of opake particles muſt render the whole opake.

THE only other hypotheſis is, that it is really converted into earth. This hath been hard to conceive by mechanical philoſophers, who do not conſider there may be qualities in an aggregate, which are not perceived in the particles of that aggregate; that is, the ultimate element muſt not be elaſtic, or fluid, but hard and unchangeable, elſe it is not an element, but an aggregate; and by thus metaphyſically conſidering the thing, the caſe is much eaſier conceived.

THIS makes good Sir Iſaac Newton's conjecture, that water might be convertible into ſalts, glaſs, &c.

THIS fact is of great importance to chemical philoſophy, and the general ſtudy of nature; hence, with Thales, numbers are led to think, that water is the only element, from which ariſes all other bodies.

THERE is, perhaps, no getting at pure water; it is tinged or mixed, leſs or more, with other heterogeneous bodies.

SINCE then ſo great a quantity of earth is obtained; that is, ſince ſo great a quantity of water is convertible into earth by diſtillation, agitation, and trituration, it would ſeem, that this globe of ours will at laſt turn out to be a dry, hard, parched maſs of matter, unleſs earth is found convertible into water again; becauſe we ſee that the ſea is ſubject to the two laſt circumſtances, which produce earth; and as yet we have never been able to recover it. Perhaps we are not to look for this.

FROM experiments and obſervations, that have been made on the Baltic ſhore, and weſt coaſt of Sweden, it is found, that the water hath not only left the ſhore (which appearance is generally aſcribed to the accumulation of ſand, or earth, brought down from the hills by rivers) but it is alſo obſerved, that the level of the ſea, when compared with that of the huge immoveable rocks, has fallen in the proportion of about thirty-ſeven inches in an hundred years.

I HAVE rather made a digreſſion, but ſhall now attend more particularly to our ſubject; and from what has been delivered on the properties of ſalts, &c. ſhall explain thoſe of water, which will be of much greater uſe to the bleacher.

ALL impurities in water are produced by foreign admixture. Thus rain falling on the higher grounds, and penetrating through the ſoil, finds its way through different ſtrata, until it comes out on the low grounds; and according to the different ſtrata it paſſes through, it turns out more or leſs pure.

THUS rivers or ſtreams, running from moſſy grounds, are tinged of a deep brown colour, not by an infection of putrifying matter from the moſs, as the moſt eminent chemiſts ſuppoſe, but, as I imagine, by an infuſion of a particular living vegetable, which compoſes moſs or turf; for indeed moſs water is found to be very antiſeptic, or to reſiſt putrefaction ſtrongly.

THE waters of rivers and lakes are much infected with animal and vegetable matter, particularly a living aquatic inſect,

ſect, which is found in great numbers in ſome waters.

BUT the waters to be more particularly conſidered, are thoſe which paſs through metallic matter; and firſt, of hard and ſoft water.

HARD

HARD WATER.

A WATER is called hard, which will not diſſolve ſoap; but the oily part of the ſoap riſes in a greaſy ſcum. This quality of water depends upon an acid which it contains, and which is generally combined with ſome other ſubſtance, with which it adheres looſely; and the alkali of the ſoap having a ſtronger attraction for this acid, unites with it, and deſerts the oil of the ſoap, which ſwims upon the ſurface of the water.

THIS ſort of water is not only unfit for bleaching, but is alſo unfit for many of the purpoſes of life, as it will not boil vegetables nor extract infuſions ſo well as ſoft water; however, it is not neceſſary that the water ſhould be entirely free from the ſaline matter; if it contains more than 10 grains of theſe materials in the pound, is called hard.

THE variety of ſpring waters depend upon the various ſubſtances which are combined with them; ſuch as,

1. Fixed air,
2. Calcarious earth,
3. Salts,
4. Metals,
5. Sulphur,
6. Arſenic, &c.

Each of which I ſhall firſt treat of; and afterwards point out the methods or experiments neceſſary to diſcover theſe ſubſtances.

1. FIXED AIR is an ingredient in many waters; for the knowledge of which we are chiefly indebted to Mr. Cavendiſh,

who found that it was the fixed air which gave water the power of diſſolving calcarious earth, iron, &c.

If we transfer a quantity of fixed air, expelled from chalk by means of the vitriolic acid, into a quantity of pure water, it has the power of diſſolving calcarious earth, iron, &c. For inſtance, if we throw a few iron nails into water thus impregnated with fixed air, it will diſſolve a part of them, and will give the water the qualities of a mineral water, *e.g.* Piermont water.

The metals and calcarious earth found in mineral waters, before our knowledge of fixed air, was ſuppoſed to be kept diſſolved by means of the vitriolic acid, which has a ſtrong diſpoſition to unite with metals: but it was formerly obſerved, that this acid had ſo ſtrong a diſpoſition to unite with other ſubſtances, that we can not ſuppoſe it in water in a ſeparate ſtate; for in paſſing through the ſoil, it would meet with ſomething with which it would unite.

2. CALCARIOUS earth which frequently occurs in waters, and is ſuſpended in ſmall quantities by pure water; for water, after paſſing through chalk, although there is no difference in taſte, is found to have diſſolved a ſmall quantity of it; but, as before obſerved, it is generally diſſolved by means of fixed air, and the earth may be depoſited by expelling the fixed air.

MANY waters are found to contain great quantities of this earth, ſo much ſo as to incruſt the veſſels in which it is boiled; this I have ſeen in tea-kettles; the fixed air being chaſed away by heat, lets go the calcarious earth, which ſettles on the kettle in form of a cruſt.

THIS earth is found in many waters in this iſland, particularly in Lough Neagh, which is ſo ſtrong as to have the power of petrifying plants, animals, &c. which it does in this manner. The plant, or animal body, admits water through its pores, and as the water paſſes, it leaves a quantity of calcarious earth, and this fills up the pore, and ſo on as the body putrefies, the calcarious earth is conveyed into its place, and fills up the vacuities, until, when the whole is carried off, there is found in its room an indurated calcarious earth.

SOMETIMES they are only cruſted over with the calcarious earth, or are hollow within, or have their primary ſubſtance to fill up their heart.

3. **SALTS.** The moſt frequent found in waters, is the fixed foſſil alkali, which is often found united with ſulphur; theſe ſprings are diſtinguiſhed by the odour of their water, which is like that of the ſcourings of a gun, which is a ſolution of hepar ſulphuris.

COMMON ſalt is found in ſome waters. It is doubtful, if glauber ſalt ever occurs.

NITRE is found in wells that are in the middle of large cities, produced from putrid animal and vegetable ſubſtances. Margraaf obtained ſome nitre from the wells of Berlin, and it has been found in the waters of London.

ALLUM is alſo found, but very rarely.

4. Metals. The moſt common to be found is iron, which is ſuſpended by fixed air, as was before obſerved: it was formerly imagined that it was ſuſpended by means of vitriolic acid, which very ſeldom happens: indeed it occurs ſometimes, as in the ſpa water, which contains a perfect vitriol of iron.

Copper is ſometimes found.

Tin is alſo ſaid to occur.

5. As to ſulphur, I mentioned before the manner in which it is found; that is, united with the fixed foſſil alkali.

6. Lastly. Arſenic is ſuppoſed to occur in waters, but if it does, it muſt come from the working of mines, where there is great quantities of fuel uſed to ſplit

the rocks, which ſublimes the arſenic, and which may be waſhed down the ſtreams.

Now for the method of diſcovering theſe ſubſtances by chemical experiment.

In order to have an exact knowledge of ſprings, it is neceſſary to attend to ſome of the general circumſtances, as the elevation of the ſpring from the level of the ſea; the nature of the ſoil in its neighbourhood; whether there are minerals, even at a conſiderable diſtance; as alſo its colour, taſte, ſmell, and other ſenſible qualities; its temperature of heat, and the like.

The general method is to evaporate two or three gallons in an open veſſel of a moderate ſize, which has its weight marked on it, and pour in the water by degrees, until it is evaporated; then drying the matter with a gentle heat, ſo as not to decompound any of the volatile ſubſtances, if ſuch is contained; then weigh the veſſel over again, ſo by this means the quantity of ſolid and fixed parts, contained in a given quantity of the water, is found. The chemiſts collect theſe ſolid parts, and examine them by different experiments, ſuch as putting the whole into a filter, and pouring diſtilled water upon it, which will diſſolve the ſaline parts, and leave the earthy; ſo the proportion of thoſe to each other is found; and then examine the ſaline parts by evaporation, chryſtalization, &c.

I SHALL here conſider the methods of diſcovering the different ſubſtances formerly enumerated.

1ſt. THE preſence of fixed air may be diſcovered by ſome of its moſt obvious qualities, as it communicates a briſkneſs to water which ſometimes makes it ſparkle. There are alſo many ſprings, where, if animals are let down, they are immediately ſuffocated; and candles are extinguiſhed by this air. I may in this place, tho' foreign to our purpoſe, obſerve, that fixed air taken into the ſtomach, is very refreſhing, but when taken into the lungs, very poiſonous; hence a caution to avoid cellars, where liquors are fermenting, and the like.

THIS water, beſides its briſkneſs, has a pungent ſour taſte, both of which it loſes upon being expoſed to the air, or upon making it boiling hot.

BUT if water contains an acid, it will not be diſſipated by expoſing it to heat, or to the air.

Another experiment, is by means of vegetable infuſions, as the ſyrup of violets; which, if diluted with common water, produces a purpliſh blue colour; but if with water containing an acid, or fixed air, a red colour is produced, but with this difference, that if the water containing air is heated, the redneſs is not produced; or if ſtruck when cold and expoſed to the air, it will entirely loſe its red colour. Thus we diſtinguiſh between a water containing air, and water containing acid.

Another experiment to diſcover fixed air is by lime water, which if added in proper quantity, occaſions a precipitation but if too much is added, the calcarious earth may be rediſſolved.

2d. To diſcover calcarious earth in waters.

IT was before obſerved, that calcarious earth is ſuſpended in water by means of fixed air.

IF lime water be added to a water in which we ſuſpect calcarious earth, there will be a very copious precipitation; for both the earth of the lime water, and that of the other water, will be precipitated; for the lime in the lime water attracts the air which ſupports the calcarious earth in the other water, which alſo falls to the bottom; but when lime water is mixed with common pure water, which does not contain fixed air, there is no ſuch precipitation, particularly if diſtilled water be uſed.

BUT the niceſt manner to diſcover calcarious earth is, by means of a ſolution of lead in the nitrous acid, which if added to a water in which calcarious earth is, the lead will be precipitated, which produces a muddineſs. In this manner, I have examined the waters of Lough Neagh, and find that this water contains calcarious earth, ſupported by means of fixed air.

3dly. Salts. As I ſaid before, I doubt much if ever they occur in water in a ſeparate ſtate; but if they ſhould, acids are diſtinguiſhed by adding a ſmall quantity of the infuſion of the ſcrapings of radiſhes; though brought to boiling heat, it will ſtill ſtrike a red colour.

If alkali is ſuſpected in water, by adding the ſyrup, or infuſion of violets, the leaſt quantity of that ſalt will turn it to a green: whether the alkali be fixed or volatile is known, by adding a ſolution of corroſive ſublimate; for the ſmalleſt quantity of the volatile alkali will change the colour of corroſive ſublimate to a white.

4thly. THE metallic ſubſtances are ſuſpended by means of acids, or fixed air; iron in particular is ſuſpended in this manner, which is eaſily detected by means of the Pruſſian alkali, the moſt minute quantity coming into view.

IT is beſt to have a Pruſſian alkali, ſaturated with ſome tinging matter, as by digeſting it with ſome Pruſſian blue, already prepared, it is neceſſary to add a ſmall portion of acid, otherwiſe the colour ſeldom appears.

THE Pruſſian alkali, when fully ſaturated with tinging matter, is a nice precipitant of metallic ſubſtances.

But, beſides this trial, it is uſual to try the water with galls, which ſtrike a black colour, more or leſs, according to the quantity of iron.

If the water contains copper, the colour produced by the Pruſſian alkali is reddiſh; the Pruſſian alkali in ſome meaſure reſtoring metals to their proper colour.

Zinc is diſcovered by adding ſome Pruſſian alkali, which will precipitate the zinc; then collect this precipitate, mix it with a minute quantity of charcoal duſt, and put it between two copper plates; if it is zinc, upon being expoſed to the heat, it will be reſtored to its metallic form, and will convert the copper into braſs.

5thly. Sulphur, as was remarked, is ſeldom found unleſs combined with an alkali; to diſcover which, we put a piece of paper marked with ſaccharum ſaturni, over a veſſel into which the water we ſuſpect is put; and whilſt the ſulphureous vapour exhales, it darkens the mark, and renders it viſible; this is a very nice method of diſcovering ſulphur combined with alkali.

ANOTHER trial is, to put a piece of ſilver into ſuch waters, and it is ſoon tarniſhed; by the adheſion of the principle of inflammability to its ſurface.

6thly. ARSENIC can be no other way diſcovered in water but by evaporating part of the water, and examining the dry reſiduum; a little of this, mixed with charcoal duſt and alkali, and expoſed to heat, will give out arſenical ſteams like garlic; or by cementing it with copper, it will give it a ſilvery whiteneſs.

FROM what has been ſaid of waters, the bleacher may underſtand how to cure theſe different waters.

THUS hard water is made ſoft, by adding to it as much alkali as will neutralize the ſaline acid matter, which gives it that hardneſs, which was long ſince taken notice of by Dr. Shaw, and lately by Dr. Home.

IF the water contains alkalies, add acids to neutralize them.

IF water contains metallic ſubſtances, add the different acids, which are the ſolvents of theſe metals: thus the vitriolic acid will anſwer theſe waters which contain iron, zinc and copper, &c.

BUT it is much better for the bleacher entirely to avoid theſe waters, for all impregnations with bodies ſuſpended in that fluid, whether they are earthy, ſaline, or metallic, retard, nay often entirely put a ſtop to the whitening of linen cloth.

As it is therefore of ſuch conſequence to the bleacher, I have pointed out methods, by which he may diſtinguiſh theſe waters from others, in order to ſhun them in the ſituation of his bleach-field; as I know many bleach-fields, the waters of which are ſo impregnated with ſome of the bodies I have mentioned, that thereby linen is bleached in them, at one fourth more the expence of materials than is neceſſary; and further they can never have very white linen.

THE ſpecific gravity of water, and conſequently its goodneſs by its lightneſs, are to be directly judged of by the hydroſtatical ballance. This experiment is a good ſubſtitute for ſeveral other ways of examining the purity and goodneſs of waters, for it appears by numerous inſtances, that light waters are, *cæteris paribus*, the beſt.

N. B. In examining waters by the hydroſtatical balance, attention muſt be paid to the thermometer, as cold condenſing water cauſes it to have more ſpecific gravity than that which is hotter; on this account water is ſpecifically heavier in winter than in ſummer. The time of the day may alſo cauſe a difference.

OF

HEMP, FLAX, &c.

FROM what has been ſaid, I imagine the properties of moſt of the bodies employed in bleaching are underſtood; then, according to the plan propoſed, I ſhall proceed to conſider the application of theſe bodies, or the operations in the art of bleaching.

BUT let us firſt conſider the nature of the ſubſtance we are to operate on; or let us conſider the nature of hemp and flax, and the nature of the ſubſtance we are to extract from flax, in order to give it whiteneſs.

IT is evident that hemp, and flax (of which cloth is made) like all other vegetables,

tables, receive their green colour, their aromatic, and perhaps their unctuous oils from the light of the ſun.

For if a vegetable be allowed to grow ſo that the light of the day be perfectly excluded, it grows indeed pretty quickly; but both the ſtem and leaves continue of a whitiſh colour.

Experiments have been often made with vegetables planted, and covered with boxes that admitted the air, but excluded the light of the ſun, the boards being made to overtop one another, and the ſides painted black, ſo as to abſorb the rays of light, whilſt the air had a free paſſage.

In like manner plants covered with glaſs, ſo as to exclude the air, but to admit the light, grow in their uſual manner, and have their uſual green colour.

WE alſo ſee that living vegetables have a ſtrong attraction for the light. This is proved by obſerving a flower-pot in a window; for whatever way the pot is turned, the plant will always turn towards the light: and, for the ſame reaſon, trees grow more upright in a thick wood, than in any other ſituation. When the light is admitted from above, they have a tendency directly upwards: and there is no way of having a tree tall and ſtraight, but by making it grow thick in this manner.

FROM excluding the light, we have the proceſs of blanching vegetables.

IT appears alſo, that the ſun has the power of giving the principle of inflammability to living vegetables. They alſo derive this principle from putrid animal and vegetable ſubſtances, *i. e.* from the manure which is put in the ground, which the ſoil contains in which they are produced: and flax of which linen is made has a ſtrong power of attracting this principle from the ſoil; for farmers tell me, that nothing exhauſts their ground ſo much as a crop of flax.

THAT plants receive chiefly their principle of inflammability from the light, appears from the green colour, which reſides in an oily matter. For by ſqueezing the leaves of a ſucculent plant, there is obtained a green liquor; and allowing this to ſtand, it will ſeparate, and the liquor will become muddy, and depoſit a ſediment, containing the whole of the green colour, which is only diffuſed in the water, and is of an oily nature, not ſoluble in water; then pour off the liquor, dry the ſediment, and you have a cruſt, containing the oily matter, which when infuſed in ſtrong ſpirit of wine, will give it a fine green colour; but by evaporating the cruſt, a few drops of oil will be obtained, which will at firſt be of a green colour; but it will certainly fade, and loſe its green colour, when expoſed to the light of the ſun. From this I would conclude, that the light of the ſun, or the light of day, was the principal agent in bleaching, and that the ſun has the power of giving the principle of inflammability to living vegetables, and of extracting it from dead vegetables, in the ſame manner as living vegetables decompound fixed air, which dead and putrid vegetables generate.

I OUGHT to have inſerted the light or principle of inflammability, amongſt the bodies employed in bleaching. No doubt ſome perſons would think it very ſtrange; yet any perſon acquainted with natural philoſophy, would make no doubt of the principle of inflammability being a material body. To prove which, let us attend to what happens in electricity.

1. HEAT and light always accompany the electrical ſpark, which, if ſufficiently ſtrong, will explode into vapour all volatile bodies, will melt all fuſible bodies, and kindle all inflammable bodies.

2. A STRONG ſpark falling on Bolognian phoſphorus, renders it luminous for ſome time, in the ſame manner the ſun's light does.

3. A LONG ſucceſſion of ſparks, made to fall on a ſmall quantity of air, converts it into fixed air. This appears from many facts; the air of a room in electricity, to which ſparks are copiouſly imparted, acquires the ſmell of fixed air.

A TRAIN of electrical ſparks change the colour of flowers, in the ſame manner fixed air does. When received on the tongue, they impreſs the ſame acidulous taſte, which is impreſſed by fixed air.

WHEN they are made to fall on lime-water, they precipitate the lime from it, in the form of a crude calcareous earth.

4. WHEN they fall on the calx of biſmuth, or of ſilver, they blacken it in the ſame manner as the ſun's light, or any

inflammable matter does. From theſe facts, I think we muſt neceſſarily infer, that the principle of inflammability is a material ſubſtance, and that in the communication of electricity the fire paſſes from one body to another.

THE beſt philoſophers are now pretty much agreed, that heat, fuſion, and evaporation, are not, as ſome have ſuppoſed, internal motions and vibrations of the parts of bodies, but are the effects of a certain ſubſtance to which they give the name of FIRE.

ALL the experiments which have been made on the Bolognian phoſphorus, concur in ſhewing that it imbibes that matter, which produces or always accompanies light; and again emits it in the ſame manner as certain bodies imbibe and give out moiſture.

THE effect of the ſun on metallic calxes, and on plants, leaves no room to doubt that this light imparts to them that matter which is the metalline form, and inflammability of metals, and which is the ſource of the feculæ, and the oils of plants.

IN like manner, all our experiments on the inflammation of bodies, ſhew us, that the principle which gives them inflammability, and which we muſt conceive to be material, ſince we ſee it paſs unchanged from one body to another, leaves them in the act of inflection, and, uniting with common air, compoſes fixed air; and in all caſes in which this principle leaves the body ſuddenly, and in conſiderable quantity, in order to unite itſelf with air, there is a production of light and heat.

On the other hand, the decompoſition of fixed air, by the growth of plants, and the reduction of metalline calxes, by means of chalk, ſhew that this compound may be decompounded, and the principle of inflammability may be united to other bodies.

From all theſe facts we cannot doubt of the materiality of the principle of inflammability; and we are, in a manner, under the neceſſity of ſuppoſing, that in the production of fixed air by the electric ſpark, a material ſubſtance paſſes out of one of the bodies, and unites with the air of the atmoſphere, rendering it fixed air.

I think what I have ſaid fully proves, that the principle of inflammability, or the light of the ſun, is a material ſubſtance; and I further imagine this ſubſtance to have the greateſt power of all others in whitening linen.

So I am inclined to imagine that Dr. Home has fallen into an error, when he ſays, that " the whole deſign of expoſing " linen cloth to the ſun, air, and winds, " is to carry off, by the evaporation of " water, whatever has been looſened by " the former proceſs of bucking ;" and which, he alſo ſays, " is a ſpecies of diſtil- " lation, performed in the open air."

But I can never be of this opinion, until I am informed linen has been bleached, in dark rooms, by means of ſtoves, or the like, as readily as in the open light, which I ſuppoſe would not be the caſe. On the other hand, I imagine linen would bleach readily, if perfectly excluded from air, by means of glaſs, and expoſed to day-light.

If linen could be bleached by any means, without expoſing it to the light, it muſt be by means of the vitriolic acid. But more of this hereafter.

THE

OPERATIONS

OF

BLEACHING.

WHEN once the properties of the bodies employed in bleaching, are well underſtood (which I flatter myſelf are pretty fully explained in the foregoing part of this treatiſe) the operations appear ſimple, and are eaſily underſtood: they may be reduced to the following:

1. Steeping and waſhing.
2. Boiling in alkaline lixives.
3. Expoſing to the ſun's light.
4. Souring.
5. Rubbing.
6. Bluing.

WHICH different operations, I ſhall treat of according to the methods practiſed by the beſt bleachers, and ſhall make my remarks and obſervations freely.

WE are much indebted to Dr. Home for his Experiments on Bleaching, which muſt have coſt him much time and labour, and which is well worth the notice of every bleacher.

STEEPING.

STEEPING is the firſt operation which green linen undergoes; the intention of which is to free it from all ſuperficial foulneſs, particularly a farinaceous paſte and oil, which the weaver is obliged to uſe in weaving linen.

IT appears from experience, that the beſt liquor for ſteeping the brown linen in is plain water; and indeed, it is alſo agreeable to reaſon, for the paſte in the linen not only mixes with the water, but alſo cauſes the oil to mix with it, juſt in the ſame manner as we can mix oil with water, by means of a mucilage of gum arabic, or the like.

It is neceſſary that the water for ſteeping linen in, ſhould be heated to about 70 or 80 dogrees of Farrenheit's thermometer; a ſmaller degree of heat would not diſſolve the paſte ſo ſoon, and a greater degree might fix it.

Heat is alſo neceſſary to produce fermentation which it is obvious happens; yet I cannot agree with Dr. Home, in thinking, that it is the * acetous fermentation, for it rather appears to be the vinous fermentation; for ſoon after the linen is ſteeped in water, mephitic or fixed air begins to ariſe, which forms a ſcum on the ſurface, by driving up the feculent particles, which are ſeparated by the fermentation, all which happens in the vinous fermentation.

Now in the acetous fermentation there is no ſuch remarkable change; there is no

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* There are three fermentations, viz. the vinous, the acetous, and putrid.

ſuch motion of air, and a groſs unctuous matter ſeparates to the bottom.

After the cloth has been ſteeped, it is carried to the * waſh-mill and waſhed, to free it of all its foulneſs, which has been looſened by the ſteeping.

After waſhing, if the weather is favourable, it is proper to ſpread it on the bleach-field to dry, in order to prepare it for the next operation, which is boiling in alkaline lixives.

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* I ſhall in this place avoid giving a deſcription of any of the mechanical apparatus uſed in bleaching, as it properly belongs to another ſubject, which I intend to treat of hereafter.

BOILING

IN

ALKALINE LIXIVES.

AS bleachers think boiling with alkalies the moſt important operation in their art, it is neceſſary they ſhould be well acquainted with the properties of alkalies; and as moſt chemiſts now agree, that the power of alkalies in bleaching depends upon their cauſticity, it is neceſſary they ſhould know how to free alkalies of their fixed air, which I have already taken notice of in treating of lime, but ſhall now treat of it in a more familiar manner.

IT is well known to chemiſts, that if the alkaline lixives uſed in bleaching, were always deprived of their fixed air, by the addition of lime they would become incomparably more active, penetrating and powerful; the oily matter of the linen would be much ſooner taken out, and at half the expence of materials.

THESE active bleaching lixives may be made in two ways, both of them exceedingly eaſy.

1ſt. BY mixing the lime and aſhes together, with a ſmall quantity of water, and throwing them into a veſſel, to be further diluted and diſſolved.

IT is propor to obſerve, that the lime ſhould always be freſh from the kiln, and well burned: for lime, when long expoſed to the air, attracts a quantity of fixed air from the atmoſphere, in conſequence of which it becomes uſeleſs.

2d. THE other and beſt method of making the active lixive, is to add the alkali to the lime water already made.

THERE is no nicety in making lime water, for whatever pains is taken to ſaturate it, not above 16 grains of lime will be diſſolved in a pound of water, and this may ſerve as a proportion; care being taken that the * lime be freſh from the kiln, and well burned. It may be made in large quantities, and preſerved for uſe a long time, if kept in cloſe veſſels, leaſt

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* As it may be inconvenient for many bleachers to have quick lime freſh from the kiln, let them provide themſelves with a quantity of limeſtone, which they can very conveniently burn under the boilers, in which they boil the linen. Or if they diſlike this method, let them take the lime burned at the kiln, and head it up in cloſe veſſels, which they may keep for uſe.

it attracts the air, which would render it uſeleſs.

THE lime water being prepared, let the different alkaline aſhes be put into as much water as is capable of diſſolving their ſalts, moſt of which will require boiling water to diſſolve them; and when the groſs parts have ſubſided, pour the clear into a large quantity of lime water.

ON the firſt mixture of the alkaline ſolution with the lime water, the whole will become white, but in a ſhort ſpace of time the lime will all fall to the bottom, and along with it the fixed air of the alkali; ſo that this lixive does not contain an atom of lime; the lime being now at the bottom in a fine white powder, preciſely like powdered chalk; having entirely loſt its fiery corroſive quality, by its union with the fixed air of the alkali.

When the lixive is made with lime, by either of the above mentioned methods, they are to be brought to a proper ſtrength, by an addition of plain water: beſides, they are not to be made in larger quantities than what may be wanted for immediate uſe, becauſe they loſe their power on being expoſed to the open air, and in time will become as weak as if no lime had been uſed in preparing them; otherwiſe they ought to be kept in cloſe veſſels.

The method to know whether the alkaline lixive be entirely freed of its fixed air; that is, to know if lime enough has been added in preparing it.

Take up a glaſs full of the lixive, after it has grown quite clear, and drop into it a little of the vitriolic acid, diluted with half its weight of water; if there is the leaſt effervescence while the acid is dropping in, it may be concluded that lime enough has not been added.

BUT, a better method is to drop a little of the lixive into a glaſs of perfectly clear lime water, if the mixture grows white, it ſhews that the lixive has not had lime enough, and therefore a little more muſt be added; if the mixture preſerve its tranſparency, then there has been lime enough added.

ON the contrary, although a redundancy of lime in the lixive could do little harm, yet it would be unfrugal to uſe too much of it; to know which, take up a glaſs of the lixive, and drop into it a glaſs of the tranſparent ſolution of pure pearl aſhes, and obſerve whether the ſolution grows white and milky; if it does, and lets fall a white ſediment to the bottom of the glaſs, it then ſhews that there is too much lime in the lixive, and that it reqires the addition of a little more alkali; but if the mixture remains clear, then the lixive is right, both as to its proportion of lime and ſalts; eſpecially, if it alſo preſerves its tranſparency, on the addition of a little clear lime water.

BLEACHERS are at a great loſs for a method to aſcertain the different ſtrengths of their lixives, that is, to know the proportion the alkaline ſalts bear to the water they uſe.

THE hydroſtatic ball will anſwer this purpoſe.

IN this experiment, attention muſt be paid to the thermometer, as different bodies expand differently, by the ſame degree of temperature; and therefore their bulks do not keep the ſame proportion.

IT will be therefore neceſſary to have a thermometer incloſed in the ſtem of the hydroſtatic ball, which ought to be made of glaſs, not only on account of ſeeing the diviſions of the thermometer, but becauſe the alkaline ſalts would corrode the inſtrument, if it was made of metal.

LET it be obſerved, that I intend all alkaline lixives ſhould be freed of their fixed air, that is, they ſhould be in a ſtate of their greateſt perfection, previous to the examination of their ſtrengths.

I SHALL not pretend to determine the ſtrengths of the lixives neceſſary on the different occaſions in boiling linen. I ſhall leave that to the determination of the judicious bleacher.

After the ſtrength of the lixive is determined upon, we next heat it to about 80 or 90 degrees of Farrenheit's thermometer, before the cloth is put into it, which anſwers much better than a boiling heat; juſt in the ſame manner as when we want to ſoften, or extract the juices out of any vegetable ſubſtance, we find it more proper to give gentle degrees of heas at firſt, and to advance gradually, than to put it immediately into boiling water. It is alſo neceſſary that the cloth ſhould be dry before it is put into the lixive, that the ſalts may enter into the body of the cloth along with the water; for they will not enter it in ſuch quantity, if it be wet. It is alſo improper to put cloth into a cold lixive.

WHEN the cloth is put into the boiler, by attending to the above directions, we encreaſe the heat, and the action of the ſalts are always in proportion to the heat.

I REMEMBER, that bleachers in this country formerly uſed cloſe covers to their boilers, by which means they could encreaſe the heat very much; but a few years ago they threw them aſide, ſo that now they can not encreaſe the heat of the liquor beyond its boiling point, becauſe it is under the preſſure of the atmoſphere.

Now, what foundation there could be for the diſuſe of theſe covers I know not, unleſs the bleacher wiſhed to have the cloth (during the operation of boiling) under his eye, and that by pouring in more liquid, he might prevent a dry heat, which would undoubtedly happen in the open boiler, on account of the great evaporation which takes place; whilſt in the cloſe boiler no ſuch evaporation takes place, and conſequently no dimunition of the liquor, which renders it unneceſſary to add any during the operation.

Again, in the open boiler, although the ſalts uſed in bleaching are more fixed than water, yet ſtill ſome of them are carried off in vapour; and further, there is an unneceſſary expence of fire, which can only encreaſe the heat to one determined degree; whereas, if the boiler be made perfectly cloſe and tight, we can encreaſe the heat to any degree, or we can encreaſe it to a neceſſary degree, with a much leſs expence of fire. Care, however is neceſſary, leſt, by encreaſing the heat too much, we burſt part of the boiler, the conſequences of which might be very diſagreeable; and alſo, as we intend to boil linen in this lixive a ſecond, or even a third time, it is neceſſary the boiler ſhould be kept cloſe (altho' not boiling) leaſt the lixive attracts fixed air, which would render the addition of more quick lime neceſſary.

THIS operation (boiling) with the ſucceeding one (expoſing to the ſun's light) are continued alternately, until the cloth becomes pretty white, at which time there appears in it ſmall dark coloured ſpecks which the bleachers call *ſprat*, and which is much more in ſome linen than others.

IT receives theſe ſpecks whilſt the flax is growing, from the electrical matter in the atmoſphere. The farmers call it *fireing*, and tell me it happens moſt frequently in wet grounds; the exhaled vapour,

pour, as I ſuppoſe, affording a conductor for the electric fluid.

NOTHING removes this ſprat ſo readily as boiling the cloth in ſtrong alkaline lixives; a proof that alkalies act by their cauſticity, or deſtroying part of the pure fibres of the linen.

BLEACHERS formerly, inſtead of boiling, ſubſtituted what they call *bucking* that is, pumping hot lixive out of the boiler on the cloth, which were in large veſſels, and letting it run off again, and ſo repeated this for a number of times.

BUT, they have now very prudently laid it aſide, as the ſalts could by no means act ſo powerfully in this way as by boiling.

IT is neceſſary, in this place, to caution the bleacher againſt boiling too often in the foul lixive, which is already ſaturated with the colouring matter.

AFTER boiling, the cloth muſt be waſhed in the mill, or by any other convenient method, to prepare it for the next operation.

EXPOSING

EXPOSING

TO THE

LIGHT.

AFTER the cloth has been boiled and well waſhed, to free it of the ſalts, which might otherwiſe deſtroy it, it is ſpread on the bleach-field, and expoſed to the ſun's light, which, as I ſaid before, is the moſt powerful body employed in bleaching.

I ALSO obſerved, that Doctor Home was miſtaken, when he imagined that the deſign of ſpreading cloth on the bleach-field was to carry off ſomething looſened and remaining after bucking, by a continued evaporation from the ſurface of the cloth.

BUT what led him into this error was, the alternate watering and drying which was then in practice, but is now laid aſide; ſo that although no evaporation can take place, from the ſurface of dry linen, yet it is found to bleach equally well, if not better, than when wetted.

MR. BOYLE, in his experiments and obſervations upon colours, ſays;

" WHITENESS conſidered as a quality
" in the object, ſeems in the general
" chiefly to depend upon the roughneſs
" of the ſurface of the body called white,
" which gives it innumerable ſmall ſu-
" perfices, that, acting like ſo many ſpe-
" cula, in various directions, they re-
" flect

" flect the rays of light that fall on them, " not towards one another, but exter- " nally towards the ſpectator's eye." This theory is very ingenious; for we ſee that whiteneſs can be produced mechanically: thus many diaphanous bodies, ſuch as glaſs, when reduced to powder, become perfectly white; and, what is yet more particular, when pieces of black horn are ſcraped into thin curled ſhavings, and a quantity of them laid together, they appear white; ſo great and ſudden a change is produced by a ſlight mechanical motion of parts, which ſo vary their poſition as to multiply their diſtinct ſurfaces, and qualify them to reflect far more light to the eye than they did before. Perhaps the whiteneſs of linen may be partly produced, by thus mechanically multiplying the parts of its ſurface; yet I do not from this pretend to ſay, that we are acquainted with the particular arrangement of the particles of bodies, which cauſe them to reflect any particular colour; no, it is more like a philoſopher, to ſtop ſhort at the ultimate fact in philoſophy, than attempt to explain their ultimate cauſes, which, perhaps, we ſhall ever remain ignorant of.

THEN let us attend to the facts. I formerly took notice, that the light of the ſun takes the * colour out of vegetables; and there is no more ſevere trial of any colour or dye than expoſing it to the ſun's rays, in its ordinary ſtate: when condenſed by means of mirours, we know their wonderful effects in diſſipating gold, ſilver, &c. into ſmoke and vapour.

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* It is improper to dry theſe vegetables in the ſun, which we wiſh to keep their colour. On this account the finer teas are dried on copper-plates over the fire.

THE ſun's rays, or light, is of a white colour, if I may be allowed the term; for, philoſophically ſpeaking, white is no colour *, being a mixture of all the original ſimple colours in nature, which are ſeven. When a beam of white light, coming through a hole into a darkened room, falls upon a triangular priſm of glaſs, it will be refracted upon the oppoſite wall of the chambers, and produce the ſpectrum of colours; that is, 1, *Violet*; 2, *Indigo*; 3, *Blue*; 4, *Green*; 5, *Yellow*; 6, *Orange*; 7, *Red*; and, by variouſly combining theſe ſeven original colours, all the different colours of nature or art can be produced, as I have ſeen by experiment.

Now that white is a mixture of theſe ſeven colours, or, which is the ſame thing, that the ſun's light is white, appears from many experiments.

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* Black is the abſence of all colours.

Exp. 1ſt, THE ſun's rays, when ſeparated by a priſm, if received by a broad convex lens, of a large focal diſtance, will be all thrown together into a ſmall round ſpot in the focus, and appear of a white colour.

Exp. 2d, THUS alſo a powder, compounded of orpiment, purple, biſe verdigris, &c. will be white.

Exp. 3, LET any circular area be divided on its periphery, in the proportions which the colours bear to each other in the ſpectrum; then ſtriking a circle, at ſome diſtance from the periphery, the ſeveral diviſions of the ring are to be laid over with the primary colours, and alſo in the order in which they appear in the ſpectrum; then let this area, with its painted ring, be whirled round like a top, and the ring will appear white.

As a further proof of the whiteneſs of light, any white body will offend and dazzle the eyes, in the ſame manner the ſun or any luminous body does. So when the ground is covered with ſnow, thoſe who have weak ſight complain that this proſpect is very offenſive to them; and even thoſe who have good eyes find their ſight injured by it. Thus Xenophon relates, that Cyrus marching his men, for many days, over mountains covered with ſnow, the dazzling ſplendour of its * whiteneſs injured the ſight of a great number of his ſoldiers, and blinded ſome of them: and many accounts of this nature are in authors of good note.

The foregoing proofs of the materiality and colour of light, muſt prevent

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* At the forges and furnaces of artificers, by a white heat they underſtand a further degree of ignition than by a red one.

me from conſidering the following theory of bleaching as hypothetical.

THAT is, that the ſun, by a long and continued action, has the power of communicating its own whiteneſs to linen and hempen cloth, as it alſo has the ſame power on many other dead vegetable and animal ſubſtances. It has this power on animal bones, ſhells, &c. wax and tallow likewiſe become white, by being expoſed to the ſun's light.

I ALSO formerly obſerved, that the Bolognian phoſphorus, when expoſed to the ſun's rays, continues luminous in the dark for ſome time after.

ALSO a piece of white linen and white paper, when expoſed in the ſame manner, gives out light in the dark.

I HAVE dwelt the longer on this ſubject, that thereby the bleacher might ſee the utility of this operation, as many bleachers are too fond of the other operations. I know ſome, who, having great confidence in boiling with ſtrong alkaline lees, have deſtroyed many parcels of linen of conſiderable value.

I HAVE ſaid, that this operation and the foregoing one (boiling) are continued alternately, until the cloth becomes nearly white, and the ſprat moſtly removed; they are then ready for the next operation, which is rubbing.

ON

RUBBING.

WHEN the cloth is pretty free of ſprat, by the foregoing operations, it is taken off the bleach-field, and drawn through a ſtream of water, which is neceſſary, in order to free it of graſs, ſand, &c. which might be hurtful to it in the mill; it is then perhaps neceſſary to mill-waſh it, after which it is laid on a table, and run over with ſoap; it is then paſſed through the rolling or rubbing boards. The linen, after being thus rubbed, is boiled in an alkaline lixive, with the ſoap that remains in it after rubbing, the ſalts being well waſhed out of it; it is then ſpread on the bleach-field, where it is allowed to lie two or three days.

This operation of rubbing ſoftens the cloth, and opens its fibres, which allows the alkaline ſalts to ſink deeper into its texture; it alſo expoſes other fibres to the action of the light, which were before concealed in the internal parts of the thread.

Many objections have been made to this rubbing mill, ſuch as, that by it the ſolid fibrous part of the cloth was worn, by which the cloth was much thinned, and in a great meaſure weakened, &c. but all theſe objections have been made by perſons ignorant of the art of bleaching.

I imagine moſt bleachers will agree with me, that cloth, after rubbing, is much thicker and ſtronger than it was before this operation, which gives it a ſort of elaſticity, ſo that it will not tear now ſo eaſily as before.

I ALSO know, that linen which is ſoft wears much better than linen which has a hard roundneſs in it.

SOURING.

SOURING.

WHEN linen has been rubbed, boiled, and well waſhed; alſo, after lying two or three days on the bleach-field, the bleacher then thinks proper to ſour it.

THE acetous acid, or ſuch as is obtained from ſaccharine juices by fermentation, was formerly uſed for ſouring linen; but this acid has now entirely given place to the mineral acids, the whole three being found to anſwer the purpoſe much better than the acetous acid; becauſe this acid has a tendency to deſtroy the linen, as it will undoubtedly run into the putrid fermentation, which never happens to the mineral acids; they, on the contrary, would preſerve linen ſound for years.

OF all the acids, the * vitriolic ſeems to claim the preference, the properties of which have been already conſidered at great length.

THIS acid may be uſed, by diluting it either with hot or cold water; when diluted with hot water, it will act as powerfully in two or three hours as it would do in forty-eight hours when diluted with cold water: ſo that hot water may be uſed, when time will not admit of uſing it cold.

BUT, in mixing it with hot water, care is neceſſary, leaſt by the ſudden exploſion and ebullition which takes place, ſmall drops will be thrown out, which may fall on parcels of linen, &c. near it, and may eat them into holes.

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* Allum has been uſed to ſour linen, but allum is nothing elſe than a particular earth united with the vitriolic acid.

It anſwers the purpoſe when diluted with cold water very well; yet, as was obſerved of ſalts in general, it would be a long time before an equal diffuſion took place, if the mixture was not agitated, the acid falling to the bottom on account of its ſpecific gravity, which is nearly double that of water; but by agitating the maſs, we can ſoon diffuſe it completely, and when once diſperſed through the water, it will never ſeparate gain.

Bleachers, not attentive to thus agitating the mixture, often corrode their linen, which they imagine is owing to the too great ſtrength of their ſours.

But I muſt here obſerve, that moſt bleachers ought to make their vitriolic ſours at leaſt four times ſtronger than they commonly do, in order to have a proper effect; for we ſee that in printing linen, in order to ſtrike the colour, they put it into a mixture of vitriolic acid and water, at leaſt ten times ſtronger than that uſed in the bleach-field; the linen remains in this mixture, which is warm, for two or three hours, and comes out remarkably whiter, and not the leaſt weakened, as I have often obſerved.

I HAVE already ſaid that the vitriolic acid does not (as is imagined by Doctors Home, Serguſon and M'Bride) act, by freeing the linen from an earthy matter that is let down on it by the alkaline ſalts; for there is no proof of any ſuch earthy matter in linen; but I ſay it acts by the attraction which it has for the phlogiſton of the flax, which phlogiſton I have already proved to be the cauſe of the colouring matter in linen, and I think is a theory very agreeable to the properties of this acid, and on this account the uſe of it ought not to be deferred, according to common practice, until the cloth is nearly white, but ought to be uſed very early in the proceſs of bleaching, care being taken that the linen be free of the alkaline lixives. And it appears from experiments made by a friend of mine, that linen can be bleached in this way in half the time that is employed in the uſual way. The only objection he has to this method, is, that the cloth feels hard and rough, and will not take a fine finiſh, as he calls it.

BUT to return to the method commonly practiſed.

AFTER the cloth has remained ſome time on the field (if the weather permits) it muſt be put dry into the ſour; by this means the acid ſalts will enter its texture, and act upon it more powerfully than if wet.

WHEN it has remained a proper time in the ſour, it is taken out and well waſhed, to free it of the acid, that thereby it may take the ſoap to prepare it for another rubbing, boiling, &c. which it undergoes, with two or more ſourings afterwards.

CARE ſhould be taken not to ſour linen in metal veſſels, as the vitriolic acid readily diſſolves iron, zinc, and copper, and can be united to all metals when boiling hot.

ON this account, nothing takes iron ſtains or ink out of linen ſo readily as a ſtrong ſour of the vitriolic acid; becauſe this acid is a ſtrong ſolvent of iron; and ink is nothing elſe than iron combined with an aſtringent vegetable ſubſtance.

From the properties of the other two mineral acids, and by comparing their prices, the bleacher will be enabled to judge, how far they may be employed in bleaching.

BLUING.

THE cloth is taken out of the laſt ſour, and well waſhed in the mill, to prepare it for the next operation, which is bluing.

LINEN cloth is blued in the bleach-fields with ſmalts, which is obtained from a metallic ſubſtance, called, *cobalt*, and which, I am informed, abounds in the mountains of this neighbourhood *.

THE only uſe of this metallic ſubſtance is to extract arſenic from it, which they do by roaſting it in an oven, ſo that the ſteams are directed into a long vent, and the condenſible parts are afterwards ſwept out and refined. Upon the floor of this oven there is found a brown coloured * calx, which, melted with glaſs, or which is the ſame thing, with the materials that compoſe glaſs, gives it a blue tinge.

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* Roſſtrevor, in the county of Down.

THE glaſs is afterwards ground to a fine powder, and is called *ſmalt-blue*, which is the ſame uſed in the bleachfield.

THIS ſmalt-blue having more ſpecific gravity than water, will ſink in it, which obliges the bleacher to uſe ſome mucilaginous or gelatinous ſubſtance, in order to ſuſpend it and keep it equally diffuſed through the water, leaſt the linen ſhould be ſtreamed, or unequally coloured by it.

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* It is alſo mixed with flinty matter, and ſold by the name of *Zaffre*, and is purchaſed to decorate porcelain and delft-ware with.

Now, ſtarch is found not to anſwer the purpoſe ſufficiently, being alſo diſpoſed to ſink in water.

A SMALL quantity of gum, or even animal glue, boiled in the water, in order to give it a ſmall degree of viſcidity, will anſwer the purpoſe very well; it is alſo neceſſary that the ſmalts ſhould be boiled.

THIS viſcid ſubſtance is alſo neceſſary on another account; it prevents the ſmalt-blue from coming out of the cloth, when dry, which otherwiſe it would do by the handling, which it is ſubject to.

MANY bleachers expoſe the linen to dry, with a great quantity of this blue liquid in it, by which means, the cloth appears much thicker than it otherwiſe would; not that this liquid has a greater power to give it this appearance than any other; for plain water would have the ſame, if not a greater effect, in producing the thick appearance which it does in this manner. When linen cloth is put into water, the water enters its texture, and ſwells up the thread, by cauſing the fibres to occupy their greateſt ſpace; when thus expoſed, and the water allowed to evaporate, it will ſtill retain its full appearance: whereas, if the cloth be wrung, or the water forced out of it mechanically, it will appear raw and thin.

THERE is no other method of detecting this fraud (if I may ſo call it) than by waſhing the linen, and wringing it hard.

AFTER the cloth is blued, if the weather is favourable, it is carried out and dried in the ſun, which anſwers the purpoſe much better, than the drying-houſe.

FROM this, the cloth is carried to the beetling-mill, where it undergoes an operation, which is not leſs deſtructive to it, than troubleſome to the bleacher.

HOWEVER, it is neceſſary that linen cloth ſhould be calendered, or even get ſome boiling, in order to give it a little ſtiffneſs that may make it the more eaſily handled, and alſo to prevent it from being ſoiled by the handling, which it is ſo often ſubject to in the different markets.

But inſtead of this, they beetle it in this mill in ſuch a manner, as often deſtroys the texture of the linen, and gives it a poliſh equal to that of the moſt finiſhed marble, which, in my opinion, only ſerves to make it look worſe.

MARKING LIQUID.

I SHALL conclude this elementary treatiſe, by giving a method for making a liquid for marking brown linen, which I underſtand is kept a ſecret in the hands of perſons who find the making of it profitable.

IT is nothing more than a ſolution of ſilver in the diluted nitrous acid; for this acid will not diſſolve ſilver in its ſtrongeſt or concentrated ſtate.

WHEN the ſilver is pure, the ſolution is perfectly limpid and colourleſs; but in common ſilver, there is a quantity of copper

per mixed with it, which will give it a blue colour.

When this ſolution is put upon the linen, it aſſumes the dark colour which is produced by the action of the light upon the ſilver; for when the ſolution is expoſed to the air, the acid, of conſequence, is evaporated, and the ſilver in ſome meaſure ſeparated, and recovers from the light the principle of inflammability, for it will never appear if preſerved in a perfectly dark place: this appears evidently by ſtaining a piece of paper with it, and placing it ſo, that one part is expoſed to the light, and the other covered up; that expoſed to the light acquires the dark colour, while the other remains colourleſs.

THIS ſolution, if properly made, ſupports the action of bleaching without the ſmalleſt diminution of its darkneſs.

THE operation of bleaching, having rather a tendency to increaſe its blackneſs; the only means of taking it out is by the application of aqua-fortis itſelf, which, with a gentle heat, diſſolves the metal again, and occaſions the mark to diſappear.

THE EXACT METHOD OF MAKING THIS SOLUTION:

TAKE a quantity of ſilver, and pour on it as much aqua-fortis as will diſſolve it; when it is diſſolved, add as much water as will prevent the acid from corroding the linen. This ſolution is then ready for uſe *.

It is proper to obſerve here, that the acid ſold in the ſhops, by the name of aqua-fortis, is commonly adulterated with the vitriolic or muriatic acid; ſo that it will be proper for perſons, making this ſolution, to purchaſe the ſtrong nitrous acid, and dilute it with water, ſo that it may diſſolve one half its own weight of ſilver.

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* In this manner I have made as much of this ſolution for 3*d.* as thoſe gentlemen who have the ſecret ſell for *half a crown*.

It may alſo be proper to obſerve, that the ſilver uſed for this purpoſe ought to be free of alloy or copper, as the acid has a ſtronger attraction for copper than for ſilver, in conſequence of which the ſilver will be precipitated.

Persons marking linen with this ſolution complain, that, on account of its tranſparency, they cannot immediately ſee what they have done, and wiſh there was ſome fecula, or colouring matter in it, that thereby it might appear.

For this purpoſe, I have added charcoal from cork-wood, or from the ſmoak of a lamp; but, upon reflection, I find that charcoal, being inflammable, will unite with the acid, for which it has a ſtrong attraction, and will precipitate the ſilver.

PRUSSIAN blue has been propoſed, but when it is conſidered that iron enters the compoſition of this blue, which has a ſtrong attraction for this acid, the ſilver would be entirely precipitated.

IN ſhort, I cannot at preſent think of any ſubſtance which will anſwer this purpoſe without injuring the liquid.

THIS ſolution does not well anſwer the purpoſe of marking white linen; the fibres of white linen being ſo fine and ſoft, that this ſolution ſpreads in it by capillary attraction.

FINIS.

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